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ABSTRACT

This handbook provides instructions for observing, identifying, and recording aviation weather at Limited Aviation Weather Reporting Stations (LAWRS) and Supplementary Aviation Weather Reporting Stations (SAWRS). Official technical definitions, meteorological and administrative procedures are outlined. Although this publication is intended for use by Federal Aviation Administration weather observers at LAWRS and SAWRS facilities, the information in it may be of use to anyone involved in meteorology or aviation. Contents include introduction, general procedures, sky conditions, visibility, atmospheric phenomena, pressure, temperature and humidity, wind, and special observations, local observations, and significant remarks. (MR)

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Federal Meteorological Handbook No. 9

Aviation Weather Observations

For Supplementary Aviation Weather Reporting Stations (SAWRS) and Limited Aviation Weather Reporting Stations (LAWRS)

Prepared June 1, 1976
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RECORD OF CHANGES

Supplement or Change No.	Effective Date	Initials	Date Entered	Remarks if Required

PREFACE

This Handbook was prepared by an interagency group representing the Department of Commerce (NOAA/National Weather Service) and the Department of Transportation (FAA) for use at Supplementary Aviation Weather Reporting Stations (SAWRS) and Limited Aviation Weather Reporting Stations (LAWRS). No other stations are authorized to use it as an observing Handbook.

Most instructions in this Handbook have been edited from Federal Meteorological Handbook No. 1 (FMH-1) but because of some differences in instructions, only this Handbook should be used at SAWRS and LAWRS.

All information required to report an individual element is contained in one chapter; the only exception is Chapter 9 where criteria for Special and Local Observations are given.

Changes altering instructions at both SAWRS and LAWRS:

a. Use GMT on all observation forms. Change "LST" to read "GMT" at the top of column 2 on MF1-10C.

b. Retain carbon copies of MF1-10C on station 6 months.

c. Use black ballpoint pen on MF1-10C. Do not erase entries on the form.

d. Record Specials are no longer required.

e. Report altimeter setting as missing (M) rather than estimated.

Changes altering previous instructions at LAWRS:

a. Use balloons in preference to other types of "Estimated" ceilings when the ceilometer is inoperative.

b. A daily check of each ASI is required against a mercury barometer or adjacent WSO or FSS.

c. If ASIs are not reliable, use a mercury barometer on the airport to determine altimeter setting. If a mercury barometer is unavailable, report altimeter setting missing.

Changes altering instructions in WSOH #4, First Edition used at SAWRS:

a. Sky cover contractions are used in place of symbols.

b. Only three ceiling designator letters are authorized (M, E, and W).

c. Visibility may be reported to any reportable value regardless of the distance of the furthest visibility marker. The + is no longer used.

d. Only sky cover observed from the station is reported in column 3.

e. New definitions of Fog and Ground Fog changes criteria for differentiating GF and F.

f. Altimeter setting indicators may now be compared against the setting of an adjacent station provided wind and distance criteria are met.

g. Very light (--) precipitation intensity is no longer reported.

On the effective date of this Handbook, WSOH#4, SAWRS Surface Observations will no longer be used as an Observing Handbook.

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CHAPTER A1

INTRODUCTION

1. Purpose. This Handbook provides instructions for observing, identifying, and recording aviation weather at Limited Aviation Weather Reporting Stations (LAWRS) and Supplementary Aviation Weather Reporting Stations (SAWRS).

2. Observational Procedures. Procedures in this Handbook assume that Record observations are taken hourly and Special and Local observations are taken as required by instructions in this Handbook, local agreements, and need for observed data. Weather observations recorded on Meteorological Form 1-10C (MF1-10C) and reported by observing stations will reflect conditions observed from the usual point of observation and unless otherwise specified, must have occurred within 15 minutes prior to the time recorded on MF1-10C.

3. Changes to the Handbook. Corrections, deletions, additions, and similar modifications will be issued by the National Weather Service as necessary under the titles "CHANGE NO. 1, 2, 3, etc." New text altering previous procedures will be indicated by an asterisk in the left margin. Enter the change number, effective date, your initials, and date entered on page ii of this Handbook.

4. Unforeseen Requirements. No set of instructions can cover all possibilities in weather observing. The observer must use his own judgment, adhering as closely as possible to this Handbook to describe phenomena not adequately covered by specific instructions. If the observer feels that Handbook procedures require change or clarification he should suggest such change thru normal administrative channels to the National Weather Service.

5. Procedures Not Applicable to all Stations. Some instructions in this Handbook are preceded by abbreviations in parentheses. These instructions apply only to the stations represented by the abbreviations as follows:

(SAWRS) Supplementary Aviation Weather Reporting Stations

(LAWRS) Limited Aviation Weather Reporting Stations

Instructions not preceded by abbreviations apply to both LAWRS and SAWRS.

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CHAPTER A2

GENERAL PROCEDURES

1. General.

1.1 Content. This chapter explains types of surface weather observations, and prescribes general practices for observing and recording them.

1.2 Surface Aviation Weather Observing Location. For purposes of taking meteorological observations, the location is defined as the point or points at which measurements are taken of the various elements in the observation. In cases where an instrument is located away from the weather office with its readout in the weather office the station location for that element being measured is the location of the instrument. For example, at an airport the aviation weather reporting station may be at the following points.

a. With respect to visually observed elements, such as clouds, prevailing visibility, weather, or obstructions to vision, the station location is in the tower or immediately adjacent to the weather station office;

b. With respect to temperature, dew point, and wind the station location might be the center of the runway complex;

c. With respect to cloud height and ceiling the station location might be a point near an approach end of a runway.

1.2.1 Multiple Observing Locations. Normally, multiple locations will be confined to an area within about 2 miles of the station location. In cases of, or reports of, distant phenomena such as "clouds over mountains NW," "lightning SE," "showers W," the concept of multiple station locations is not extended to include points where the distant elements are occurring.

1.3 The Weather Observer.

1.3.1 Certification of Observers. An observer must be certified by the National Weather Service to take official aviation weather observations. Observer certificates must be available, on station, for review.

1.3.2 Observer Responsibility. In addition to taking and disseminating accurate, scheduled observations, the observer must be alert to significant changes in weather conditions that could have an adverse effect on aviation safety. He should take and disseminate observations as rapidly and accurately as feasible to report these changes when they are observed to occur.

2. The Weather Observation.

2.1 Aviation Weather Observations. These observations are taken by certified weather observers to report meteorological conditions. Contents of these observations are listed in table A2-1.

2.2 Types of Observations (Column 1 of MF1-10C). The three types of weather observations made by SAWRS and LAWRS are classified as follows:

Record (R) Observations. Taken routinely on an hourly basis.

Special (S) Observations. Taken whenever mandatory criteria are met and, at the discretion of the observer, to report significant weather changes. (See paragraph A9-2.) SAWRS 135 operations will use this classification instead of R but content will be the same as a Record observation.

Local (L) Observations. Taken anytime when locally established criteria are met or when an aircraft accident or incident occurs or for any meteorological situation that in the opinion of the observer is critical to local operations. (See paragraphs A9-3 and A9-4.)

2.3 Time Standards. Times used in Aviation Weather observations are with reference to the 24-hour clock and reported in GMT.

2.3.1 Local Standard Time (LST). A time based on one of the 24 standard time zones of the globe. The zone is determined by the geographic locations of the station, therefore, is not subject to change.

2.3.2 Greenwich Mean Time (GMT). The standard time at Greenwich, England. It is not subject to change and is the time used internationally on all weather transmissions. In the Western Hemisphere, conversion to GMT, as indicated below, is made by adding to LST, depending on the time zone of the station.

STANDARD TIME ZONE	TO CONVERT TO GMT ADD	FOR EXAMPLE, 1200 LST EQUALS:
Atlantic Standard Time	4 hours	1600 GMT
Eastern Standard Time	5 hours	1700 GMT
Central Standard Time	6 hours	1800 GMT
Mountain Standard Time	7 hours	1900 GMT
Pacific Standard Time	8 hours	2000 GMT
Yukon Standard Time	9 hours	2100 GMT
Alaska-Hawaii Standard Time	10 hours	2200 GMT
Bering Standard Time	11 hours	2300 GMT

2.3.3 Actual Time of Observation (Column 2 MF1-10C). The time (GMT) the last element of the observation is observed or evaluated.

2.3.4 Standard Time of Observation. The GMT hour to which a Record observation applies.

2.3.5 Accuracy of Time in Observations. The accuracy of the actual time of observation is of the utmost importance in aviation safety investigations. One clock should be designated as the station standard and checked daily at part-time stations or on each shift at full-time stations.

2.4 Recency of Observed Elements. Individual elements entered in an observation must as closely as possible reflect conditions existing, or unless otherwise specified, have been observed within 15 minutes of the actual time of observation.

2.4.1 Order of Observing. Elements having the greatest rate of change are evaluated last. When conditions are relatively stable, evaluate weather elements in the following order:

a. Visually evaluated-----Sky condition, visibility, weather, and obstructions to vision.

b. Instrumentally evaluated-----Temperature, wind.

c. Instrumentally evaluated last-----Altimeter Setting.

3. Federal Meteorological Form 1-10C (MF1-10C).

3.1 Purpose. MF1-10C is used to compute and log the elements in a weather observation. After completion and verification these forms are archived as the basic record of surface observations taken at a station.

3.2 Preparing MF1-10C. Prepare an original and at least one carbon copy of MF1-10C. Data for more than 1 day may be entered on the same sheet, separating data for different days by a line containing the day, month, and year of the data which follow it. All dates and times on this form are GMT. Cross out L.S.T. in the heading of column 2 and insert GMT.

3.3 Entries on MF1-10C. Certified observers will normally complete all entries on MF1-10C. Non-certified trainees may make entries on the form under the immediate supervision of a certified observer who attests to the validity of the entries by initialling in column 15. Make entries in accordance with the following paragraphs.

3.4 Writing Instrument. Use a fine, black, ballpoint pen to make entries on MF1-10C.

3.5 Separating Data. Use slants (/) in column 13 to separate data which, if not separated, might be misinterpreted.

3.6 Missing Data. Indicate normally observed missing data by entering M in the appropriate space. M is not used in column 13. Explain briefly the reason for missing data in block 90, Remarks, Notes, and Miscellaneous Phenomena.

3.7 Remarks (Column 13). Columns 1-12, on MF1-10C, are labeled to specify the data entered. Column 13 is used to record operationally significant data not recorded in column 1-12 but disseminated as part of the observation. Instructions for entering remarks are contained in this manual. Other remarks that the observer considers significant should also be recorded. Make entries according to the following instructions.

a. Authorized contractions and symbols should be used to conserve time and space. However, in no case should an essential remark be omitted for the lack of readily available contractions. In such cases, the only requirement is that the remark be clear.

b. Unless otherwise directed, make time entries in minutes past the hour if the time reported is within 1 hour of the Standard time of observation. If the time is more than 1 hour prior to the Standard time of observation, use hours and minutes GMT (without GMT time zone indicator "Z").

c. Enter direction and location of phenomena in a clockwise order using 8 points of the compass; e.g., TCU NE-E.

d. Report movement of clouds or other phenomena, with respect to the direction toward which the phenomena are moving; e.g., CB MOVG E.

e. Except for visibility, report distances in nautical miles.

f. Remarks pertaining to tornadic or thunderstorm activity may be combined with those for CB/CBMAM when the direction of movement is the same; e.g., T NE AND CB SW-N MOVG E.

3.7.1 Order of Remarks. The order of entry for remarks listed below should be followed as closely as possible. Specific entry instructions are outlined in the reference paragraphs.

a. Surface-based obscuring phenomena (paragraph A3-4.5.1).

b. Wind shift (paragraph A8-3.8).

c. Other remarks elaborating on preceding coded data (paragraph A9-5).

d. Pilot reports of cloud bases and tops (paragraph A3-4.5.2).

3.8 Remarks, Notes, and Miscellaneous Phenomena (Block 90). Use this block to record both data considered significant but not disseminated, and the information described in the following paragraphs. All entries will include the time (GMT) of occurrence. Entries will be made to explain:

a. Equipment Outages. Include reasons and times of outage.

b. Reason for omission of mandatory data entries.

c. Time checks of station clock if not indicated elsewhere.

d. Change in hours of station operation, effective dates if temporary or date if change is permanent.

e. Miscellaneous items; e.g., time notified of an aircraft mishap.

3.9 Disposal of Insignificant Figures. Except where otherwise designated in this handbook, when computations require that a number be rounded, disregard algebraic signs and observe the following procedure:

a. If the fractional part to be disposed of is one-half or greater, increase the preceding digit by one:

b. If the fractional part to be disposed of is less than one-half, leave the preceding digit unchanged.

Examples: 1.5 becomes 2, -1.5 becomes -2,
29.248 becomes 29.25

c. An exception to this procedure is in reporting cloud heights and visibility. When the actual cloud height, or visibility, falls midway between two reportable values, report the lower of the two values.

3.10 Corrections. Correct entries on MF1-10C as follows:

3.10.1 Discovered Before Dissemination. Draw a line through erroneous entries and record corrections in black ink in the appropriate blocks on the same or next line.

3.10.2 Discovered in Columns 1 Through 13 After Either Local or Longline Dissemination. Draw a red line through the erroneous entry and record correction in red above it on all copies. If insufficient space is available, enter the correction in red, appropriately identified, in column 13; e.g., TEMP 69, etc. If the correction is transmitted over longline or local circuits, enter COR in red in column 13 followed by the time GMT the correction is transmitted or delivered to communications personnel.

3.10.3 Errors in Columns 17 Through 90. To make corrections in these columns, draw a line through the erroneous data and enter the correct data in black.

4. Disposition. For verification and archiving, mail by the 2d working day of each month the original copies of the previous month's MF1-10Cs to the office designated by NWS Regional Headquarters.

4.1 Retention of MF1-10C Carbon Copies. Carbon copies of MF1-10C on which all corrections have been entered will be retained on station for 6 months.

5. Instrumental Evaluations. When the observer has reason to question the accuracy of meteorological instruments he should discontinue their use until corrective maintenance, if required, is completed.

Table A2-1. Content of Aviation Observations

Elements	Type of Observation			
	R	L - for ACFT MISHAP	S	L
(1) Sky and Ceiling*	X	X	X	CONTENT DETERMINED LOCALLY
(2) Prevailing Visibility*	X	X	X	
(3) Weather and Obstructions to Vision*	X	X	X	
(4) Temperature	X	X	See Note 5	
(5) Dew Point, if required for terminal forecast	X	X	See Note 5	
(6) Wind Direction, Speed and Character	X	X	X	
(7) Altimeter Setting	X	X	X	
(8) Remarks, as appropriate	X	X	X	

*Reevaluate prior to dissemination, if practicable, to insure that data is current.

1. Record Observations (R).....Paragraph A2-2.2.
2. Local Observations (L).....Paragraph A9-4.
3. Special Observations (S).....Paragraph A9-2.
4. Single-element Special observations are only used to report TORNADO, WATERSPOUT, or FUNNEL CLOUD.
5. (SAWRS) 135 operations will report temperature and, if required, dew point on all observations.

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CHAPTER A3

SKY CONDITION

1. General.

1.1 Content. Instructions in this chapter relate to the state or appearance of the sky in reference to sky covered by clouds and/or obscuring phenomena.

2. Definitions.

2.1 Horizon. For the purpose of these instructions, the horizon is the actual lower boundary (local horizon) of the observed sky or the upper outline of terrestrial objects including nearby natural obstructions. It is the distant line along which the earth and the sky appear to meet. The local horizon is based on the best practical point of observation near the earth's surface and is selected to minimize obstruction by nearby buildings, towers, etc.

2.2 Field Elevation. The officially designated field elevation (H_a) of an airport above mean sea level. It is the elevation of the highest point on any runway.

2.3 Surface. For height determinations, the term "surface" denotes the horizontal plane whose elevation above sea level equals the field elevation. At stations where the field elevation has not been established, "surface" will refer to the ground elevation at or below the observation site.

2.4 Cloud. A visible accumulation of minute water droplets and/or ice particles in the atmosphere above the earth's surface. Cloud differs from ground fog, fog, or ice fog only in that the latter are, by definition, in contact with the earth's surface.

2.5 Obscuring Phenomena. In aviation weather reports, any collection of particles aloft (haze, fog, smoke, etc.), or in contact with the earth's surface, dense enough to be discernible to the observer.

2.6 Layer. Clouds or obscuring phenomena not necessarily all of the same type, whose bases are at approximately the same level. A layer may be either continuous or composed of detached elements. Note that a surface-based phenomenon is also classified as a layer.

2.7 Layer Height. The height, in feet, of the layer's base above the surface or field elevation.

2.8 Layer Amount. The amount, in tenths, of sky cover at a given level; i.e., sky covered but not necessarily hidden by clouds or obscuring phenomena aloft or sky hidden by surface-based obscuring phenomena.

2.9 Interconnected Cloud Layers. The condition when cumuliform clouds developing below other clouds reach or penetrate them. Also, by horizontal extension, swelling cumulus or cumulonimbus that form stratocumulus, altocumulus, or dense cirrus.

2.10 Multiple Layers. Two or more layers at different heights.

2.11 Sky Cover. A term used to denote the amount (to the nearest tenth) of the sky which is:

a. Covered but not necessarily hidden by clouds and/or obscuring phenomena aloft.

b. Hidden by surface-based obscuring phenomena, or

c. Covered or hidden by a combination of a. and b.

2.12 Sky Cover Classifications.

a. CLEAR (CLR). The state of the sky when it is either cloudless or the sky cover is less than 0.1 (to the nearest tenth).

b. SCATTERED (SCT). A sky cover of 0.1 through 0.5 at and below the level of a layer aloft.

c. BROKEN (BKN). A sky cover of 0.6 through 0.9 at and below the level of a layer aloft.

d. OVERCAST (OVC). A sky cover of 1.0 (10/10) at and below the level of a layer aloft.

e. OBSCURED (X). The condition when the sky is completely hidden by surface-based obscuring phenomena; e.g., fog, smoke, precipitation, etc.

f. PARTLY OBSCURED (-X). The condition when 0.1 or more, but not all of the sky is hidden by surface-based obscuring phenomena.

2.13 Variable Sky Condition. The term used to describe a sky condition that has varied between reportable conditions (e.g., SCT to BKN, OVC to BKN, etc.) during the period of observation (normally the past 15 minutes).

2.14 Opaque Sky Cover. The amount (to the nearest tenth) of cloud layers or obscuring phenomena (aloft or surface-based) that completely hides all or a portion of the sky and/or higher clouds that may be present.

2.15 Thin Sky Cover. That portion of sky through which higher clouds or blue sky can be seen.

2.16 Summation Amount. The amount, in tenths, of the entire sky that is covered (total sky cover) or hidden (total opaque sky cover) by layers at and below a given level. This amount cannot be greater than 1.0 (10/10).

2.17 Total Amount. The amount, in tenths, of the entire sky that is covered, but not necessarily hidden by all layers present. This amount cannot be greater than 1.0 (10/10).

2.18 Summation Principle. The principle, applied to evaluate both total sky cover and total opaque sky cover, states that sky cover at any level is:

a. The sky covered by all layers at and below the level being considered.

b. Not more than 1.0 (10/10).

c. Never less than the sky cover at a lower level.

2.19 Opaque Layer. The classification given any layer aloft when the ratio (summation at and below the level of the layer) of total opaque to total sky cover is more than one-half.

2.20 Thin Layer. The classification given any layer aloft when the ratio (summation amounts at and below the level of the layer) of total opaque to total sky cover is one-half or less.

2.21 Ceiling. A term used to indicate the height and opaqueness of a layer aloft or the vertical visibility into surface-based obscuring phenomena. Both height and the amount of sky hidden must be considered to define ceiling.

2.21.1 The Ceiling. The ceiling is the lesser of:

a. The lowest height at which total opaque sky cover aloft is six-tenths or more, or

b. The vertical visibility in a surface-based layer of obscuring phenomena.

2.22 Vertical Visibility. Vertical visibility in an obscured sky is:

a. The distance an observer can see vertically upward into surface-based obscuring phenomena such as fog, blowing dust or sand, precipitation, etc., or

b. The height corresponding to the upper limit of a ceilometer reaction, the top of a ceiling light projector beam, or the height at which a balloon completely disappears during the presence of surface-based obscuring phenomena.

2.23 Ceiling Designator Letter. A letter placed before the ceiling height which implies the degree of accuracy of the reported height. These letters are M (paragraph 3.7), E (paragraph 3.8), and W (paragraph 3.9).

2.24 Variable Ceiling. A term that describes a condition in which a ceiling of less than 3,000 feet rapidly increases and decreases by one or more reportable values while the ceiling height is being determined.

3. Observing and Reporting Procedures.

3.1 Observation Sites. Observations of layers, amount, direction of movement, height of bases, and the effect of obscuring phenomena on vertical visibility shall be taken from as many locations as are necessary and practical to view the entire sky.

3.2 Determining Layers.

3.2.1 Evaluating Multiple Layers. Frequent observations are necessary to evaluate layers. A series of observations will often show the existence of upper layers above a lower layer. Through thin lower layers it may be possible to observe higher layers. Differences in the directions of cloud movements are often a valuable aid in observing and differentiating between cloud layer, particularly when the presence of haze, smoke, etc., increases the difficulty of evaluation. Ceiling light indications may be used as a guide in determining the presence of multiple layers at night.

3.2.2 Interconnection of Layers. When clouds formed by the horizontal extension of swelling cumulus or cumulonimbus are attached to a parent cloud, they will be regarded as a separate layer only if their bases appear horizontal and at different levels from the parent cloud. Otherwise, the entire cloud system, will be regarded as a single layer at a height corresponding to that of the base of the parent cloud.

3.3 Evaluating Sky Cover Amounts. Sky cover amounts are evaluated:

a. In tenths of coverage of the entire sky area above the horizon,

b. In terms of the total amount of both thin and opaque sky cover, or total opaque sky cover only, depending upon the appearance of the sky being determined.

3.4 Procedure for Evaluating Sky Cover Amounts.

3.4.1 Advancing or Receding Layer. To estimate the amount of an advancing (or receding) layer, determine angular elevation above the horizon of the forward or rear edge of the layer as seen against the sky. Use a clinometer, if you have one, until experience is gained in estimating vertical angles. Convert the angle to tenths of sky cover (see table A3-2). When the layer does not extend to the horizon, determine the angular elevation of the forward and rear edges and the tenths of sky cover corresponding to each elevation. The difference will equal

the sky cover. For example: Forward edge 78^{o} = 0.4 sky cover; rear edge 53^{o} = 0.2 sky cover. Total sky cover is the difference between the two, or 0.2 sky cover.

3.4.2 Continuous Layer. When a continuous layer surrounds the station and extends to the horizon, determine the angular elevation of the edge and convert to tenths of sky cover (see table A3-2). Since such a distribution is infrequent, this table serves only as a guide in estimating amounts in situations that approach a configuration of a continuous layer surrounding the station.

3.5 Sky Cover Classification. Select the appropriate sky cover contraction or combination of contractions (table A3-1) to be reported after evaluating the following:

a. Estimate (to the nearest tenth) both the amount of sky covered and the amount of sky hidden by the lowest layer present. If this layer is a surface-based obscuring phenomenon, determine only the amount of sky that is hidden.

b. Determine if an additional layer or layers of clouds and/or obscuring phenomena aloft are present above the lowest layer. Estimate the tenths of sky both covered and hidden by each of these layers in combination with the lower layers. Do not add to the total coverage the amounts of upper layers visible through transparencies in lower layers, except those amounts of upper layers visible through transparent surface-based atmospheric phenomena.

c. Repeat the evaluation in b. for each additional layer present in ascending order of height. Estimate the summation tenths of sky covered and hidden by each layer, in combination with all lower layers.

d. Determine for each layer present whether it should be classified as "thin" or "opaque." This evaluation shall be based on the ratio of total opaque to total sky cover summation amounts at and below the level of each layer present up to and including the layer being classified (see figure A3-5).

3.6 Determining Layer Heights. To determine the height of layers aloft and the vertical visibility into obscuring phenomena:

a. (LAWRS) A ceilometer is used. At locations where the ceilometer is inoperative use ceiling lights or balloons.

b. (SAWRS) Use a ceilometer, if available. Otherwise, use a ceiling light or balloon.

c. Determination of heights should be supplemented by visual and, if available, other measured (paragraph 3.7) or estimated (paragraph 3.8) means.

d. Identify the ceiling with the appropriate designator M (measured), E (estimated), or W (indefinite). When more than one height evaluation is available the height should be based on the most reliable method of determination. A measured height is more reliable than an estimated or indefinite height.

3.6.1 Reporting Layer Heights. Heights of layers visible at the station will be reported in feet above the surface (not MSL) rounded to reportable increments as specified below. Use the lower height when layer is halfway between reportable values.

Range of Height Values	Reportable Increments
5,000 or less	To nearest 100 feet
5,001 to 10,000	To nearest 500 feet
Above 10,000	To nearest 1,000 feet

3.7 Measured (M) Ceiling Heights. Ceiling values are classified as "measured" when:

a. Determined from ceilometer or ceiling light when values are less than ten times the baseline of the instrument,

b. Based on the known heights of unobscured portions of abrupt, isolated objects (buildings, towers, etc.) within 1 1/2 nautical miles of a runway.

3.7.1 Ceiling Heights from Rotating Beam Ceilometers. The response of cathode-ray tube (CRT) indicator to light reflected from clouds and obscuring phenomena is illustrated in figures A3-1 and A3-2. The base of sky cover aloft is represented by points of maximum reaction of the ceilometer to light reflected from the base of layers detected.

a. When the sky is obscured by a surface-based layer, the ceilometer reaction is usually at a maximum at low angles and decreases slowly to zero amplitude as the angle increases. The absence of a reaction during low visibility conditions does not necessarily indicate that projector lamps are defective. Obscuring phenomena that reduce the visibility to less than the ceilometer baseline length can block the light beam.

b. Ceilometer reactions, such as might be caused by equipment malfunctioning, can usually be identified by dissimilarity with patterns caused by meteorological phenomena. They usually occur only occasionally and may be intensified by high gain control settings of the CRT-scope.

c. False or misleading maximum ceilometer reactions may be caused by nearby, high-intensity, flashing runway lights.

(1) Flasher interference occurs at 15 degree intervals on the CRT-scope of the rotating beam ceilometer.

(2) The reactions on the CRT-scope are in the form of pyramid-like deflections that taper off rapidly with increasing elevation angle.

(3) When flasher interference reactions are superimposed on signals from clouds that are present, the uniformity of the flasher interference signals should assist the operator in determining the angular elevation of the clouds.

d. The refraction of light from the projected beam by raindrops may produce a strong enough signal to cause a reaction on the CRT-scope. These reactions occur with greatest intensity at an elevation angle of 49 degrees. This primary reaction is without regard to the baseline length or the height of the detector above or below the projector. Weak secondary reactions may also appear at approximately 36 degrees. Ceilometer deflections from clouds at these angles are generally stronger than those from refraction phenomena, which may usually be eliminated by low gain control settings without significant weakening of cloud reactions.

3.7.2 RBC CRT-Scope Evaluation. Use the following procedure for evaluating RBC CRT-scope presentation of sky-cover reactions:

a. For heights of sky cover layers aloft:

(1) When reactions from a single broken or overcast layer are present, consider the spot of maximum deflection on the scope as an instantaneous height value. Determine a mean height value by averaging as many angular readings as available during the period of evaluation.

(2) For scattered clouds, use as many scope reactions as available during the period of evaluation to obtain an average height.

(3) When multiple layers are present, supplement scope height indications with visual observations. Average only those reactions that are considered applicable for the layer whose height is being determined.

b. When the sky is completely hidden by surface-based obscuring phenomena:

(1) Consider the point at which deflection on the scope becomes zero as an evaluation of vertical visibility.

(2) Use the average value obtained from at least four consecutive sweeps as a representative indefinite (W) ceiling height.

3.7.3 Ceiling Light Procedure. Nighttime sky cover heights and vertical visibility values may be determined with a clinometer and a projector by using the following procedures:

a. Allow the pendant to swing freely, sight through the clinometer centering the intersection of the cross-hair:

(1) Upon the brightest portion of the light beam spot when the sky cover layer is aloft, or

(2) On the upper limit of the light beam penetration when the sky is completely obscured by a surface-based layer.

b. When the pendant has come to rest, lock it in position without moving the clinometer.

c. Read the indicated angle to the nearest whole degree and release the pendant clutch.

d. Repeat steps a. through c. three times then determine an average angular reading.

e. Refer to a table appropriate for the baseline used for the equivalent height value of this average reading.

3.8 Estimated (E) Ceiling Heights. Ceiling heights of cloud layers or obscuring phenomena aloft are classified as "estimated" when determined by the following methods:

a. Ceiling balloons of known ascension rate, used with the following procedure to determine ceiling heights.

(1) Choose the appropriate color of balloon; red balloons are usually best with thin clouds, blue or black balloons with other conditions.

(2) Inflate the balloon following the instructions in paragraph 5 of this chapter.

(3) Watch the balloon continuously. Determine with a stop watch (or any watch having a second hand) the length of time that elapses between release of the balloon and entry into the base of the layer. The point of entry will be considered as midway between the time the balloon first begins to fade and the time of complete disappearance.

(4) Determine the reportable height above the surface corresponding to the elapsed ascent time in tables A3-3A and B. The accuracy of the height obtained by a balloon will be decreased when the balloon:

(a) Does not enter a representative portion of the cloud base.

(b) Is used during the occurrence of hail, ice pellets, any intensity of freezing rain, or moderate to heavy rain or snow.

(5) When a balloon is used for determining vertical visibility in an obscuration, the ceiling value shall be the height at which the balloon completely disappears. The ceiling is classified "indefinite" (W).

b. A ceiling height reported by a pilot (converted from height above mean sea level to height above surface).

c. By means of the Convective Cloud Height Diagram (figure A3-4). This diagram is used to determine height of convective-type clouds. It is not for use at stations in mountainous or hilly terrain. This method should be used only when the clouds present are formed by active surface convection in the vicinity of the station. This diagram is usually most accurate when used to compute the height of cloud bases at 5,000 feet or less. Obtain the estimated height of a cloud base above the point of observation as follows:

(1) Locate the point of intersection of the vertical line corresponding to the observed dew-point temperature, and the sloping line corresponding to the observed dry-bulb temperature.

(2) From the point of intersection move horizontally to the height scale printed in feet on the right side of the chart. This value is a good estimation of the height of the cloud base (see examples in figure A3-3).

d. From the known heights of unobscured portions of natural landmarks or objects more than 1 1/2 nautical miles from any runway of the airport.

e. On the basis of observational experience provided the sky is not completely hidden by surface-based obscuring phenomena and other guides are lacking or considered unreliable by the observer.

f. By ceilometer or ceiling light and the values equal or exceed 10 times the baseline used.

g. Based on observer experience and persistence of heights previously classified as M.

3.8.1 Balloon (E) Ceiling Heights. If the ceiling cannot be measured with a ceiling light or ceilometer, use balloons when:

a. The ceiling is at or below the minimum height for VFR operations in the airport's traffic area, or

b. The ceiling height is 2,000 feet or less and the presence of a stratus-type cloud layer makes estimation difficult.

3.9 Indefinite (W) Ceiling Heights. Ceiling heights are classified as "indefinite" when the height reported is the vertical visibility into a surface-based obscuring phenomenon. Vertical visibility is:

a. The distance an observer at the ground can see upward into an obscuring phenomenon completely concealing the sky,

b. Based on the visible portions of nearby objects (buildings, control towers, etc.) on the airport complex,

c. Based on a height equivalent to the top of a ceiling light beam, or the height at which a balloon completely disappears.

3.10 Variable (V) Ceiling Heights. Only ceiling heights of less than 3,000 feet will be reported as variable, using the average of all observed values as the ceiling. Rapid fluctuation of ceilometer indications, or of the spot from a ceiling-light projector, will indicate an irregular base whose height will be regarded as measured but variable. "V" is not a ceiling designator. It is used in combination with E or M to designate a variable ceiling height.

4. Entries on MF1-10C. Enter sky cover data in accordance with the following paragraphs. Enter data for each layer of clouds and obscuring phenomena visible from the observation site. Use column 13 to report clouds visible through thin spots or breaks in an opaque overcast layer and to report layers aloft when sky cover at and below that layer is less than one-tenth.

4.1 Sky and Ceiling (Column 3). Except as stated above enter data for each layer of clouds and obscuring phenomena present in ascending order of base height. Use an additional line if more space is needed. Use the following format.

4.2 Ceiling Designators. The ceiling height must be preceded by a ceiling designator; M, E, or W.

4.3 Height of Sky Cover. Prefix each contraction, except clear and partly obscured conditions, with the height in hundreds of feet above the surface or field elevation using the increments shown in paragraph 3.6.2.

a. Encode height values that are halfway between reportable values as the lower of the two heights.

b. Whenever the ceiling height is less than 3,000 feet and rapidly increases and decreases between one or more reportable values during the time of observation, suffix the average of all observed values with a "V" for variable. Enter range of variability in column 13 (see paragraph 4.5b).

4.4 Sky Cover Contraction. Enter sky cover visible from the observation site using the appropriate contraction or combination of contractions from table A3-1.

4.5 Entries in Column 13.

When condition observed is:	Then enter:
a. Breaks or an area absent of clouds in a layer, below 1000 feet, which covers at least 6/10 but less than 10/10 of the sky.	"BRKS" and direction from station. Omit remark if the breaks are in all quadrants; i.e., BRKS N, BRKS OVER CITY.
b. Variable ceiling height below 3000 feet.	"CIG" followed by extremes of variability separated by a "V"; i.e., CIG 15V20, CIG 26V31.

c.	Variable sky condition during the period of observation (the past 15 minutes).	Sky condition at time of observation, "V," and the condition to which it varied during the period of observation. When necessary to distinguish between column 3 entries; include the layer's height; i.e., SCT V BKN, BKN V OVC, 18 OVC V BKN.
d.	Ceiling or sky condition at a distance differing from that at the station.	Description and location; i.e., CIG LWR OVER CITY, LWR CLDS W APCHG STN, CLD BASES OBSCG MTNS W.
e.	Cumulonimbus (for which no thunderstorm is being reported).	"CB," distance from station if known, and direction from station, and movement if known; i.e, CB 20S MOVG NE, CB OVHD MOVG E.
f.	Cumulonimbus Mamma (with or without thunder).	Same as cumulonimbus, except use "CBMAM"; i.e., CBMAM 10W MOVG SE.
g.	Towering Cumulus.	"TCU," distance (if known), and direction from station; i.e., TCU NE, TCU 25SW.
h.	Standing Lenticular or rotor clouds.	Description and direction from station; i.e., ACSL SW-W, APRNT ROTOR CLDS S, CCSL OVR MTNS S.
i.	Altocumulus Castellanus.	"ACCAS" and direction from station; i.e., ACCAS SE.
j.	Breaks in overcast not classified as thin.	"BINOVC" and direction(s) from station; i.e., BINOVC NE AND S, BINOVC E, SE, AND SW. No direction required if occurring in all quadrants.
k.	Higher clouds visible through breaks in overcast not classified as thin.	"HIR CLDS VSB" and direction(s) from station; i.e., HIR CLDS VSB NE AND S. No direction required if occurring in all quadrants.
l.	Sky cover at and below a layer aloft is less than one-tenth (nearest tenth).	Type of cloud and direction from station; i.e., ST W, CUFRA N.

m.	Obscuring phenomena aloft.	Type, height, and corresponding sky cover contraction (as reported in column 3); i.e., K10 SCT.

4.5.1 Surface-Based Obscuring Phenomena. When the reported sky condition includes a partly obscured condition (-X), a remark in column 13 is required to indicate the type of phenomena (table A3-4) and the tenths of sky hidden; e.g., "F6," "S8," "KF3," etc. If the sky is completely hidden by a surface-based phenomena (X) enter in column 13 the direction of breaks or discontinuity, if any, in the obscured sky; e.g., "THN F NW," "BRK IN F SE," etc.

4.5.2 Pilot Reports of Bases and Tops. Enter reported heights of bases not visible at the station and tops of sky cover layers within 20 nautical miles of the airport for noncirriform layers and within 50 nautical miles of the airport for cirriform layers. Omit data that is more than 15 minutes old unless it is considered operationally significant. In the event of multiple reports, use the one that is most complete and in reasonable agreement with other observed data. Enter the most recent data first, and separate each layer from other layers and each report from other remarks with slants. Make entries in the following order and format:

a. UA.

b. Time in hours and minutes (GMT) if data is more than 15 minutes old.

c. Distance and direction from station, if reported.

d. Height of bases in hundreds of feet (MSL), if reported.

e. Sky cover contractions for amount reported by pilot. Enter U if amount is not reported or is unknown.

f. Height of tops in hundreds of feet (MSL), if reported.

EXAMPLES

/UA 173Ø 15SW 5Ø BKN /UA SCT 112/15Ø OVC 22Ø
/UA 11Ø5 SCT 165 /UA BKN 65/Ø835 12Ø SCT 15Ø
/UA 25U78/18ØU

4.6 Total Sky Cover (Column 21). Each Hourly observation must contain the tenths of sky covered (not necessarily hidden) by all clouds and obscuring phenomena aloft, and of sky hidden by surface-based obscuring phenomena, that are visible at the station. For example, enter 6 for six-tenths, 0 for clear or less than one-tenth, etc.

4.7 Total Opaque Sky Cover (Column 36). Enter as a whole number the total tenths of sky that are hidden by clouds and/or obscuring phenomena. Note that this entry is similar to entry in column 21 except that sky cover through which the sky can be seen is disregarded. The maximum amount entered is 10.

5. Inflation of Ceiling Balloon. The balloon should be dry inside, and relatively dry outside, especially during freezing weather. Remove any trapped air by folding and squeezing the balloon in the hand, then stretch the neck sufficiently to insert the inflation nozzle. Place the nozzle so that the tubing connecting the nozzle to the regulator rests on a support and is not suspended from the nozzle. Inflate the balloon slowly and turn off the gas as soon as the balloon begins to lift the nozzle. Add or remove gas from the balloon until the nozzle is suspended just above the support when any motion of the balloon has stopped. Listen for leaks in the balloon. Tie the neck of the balloon securely just above the nozzle, and remove the balloon from the nozzle. Double the end of the neck over the tied portion and either tie it or secure it with a rubber band.

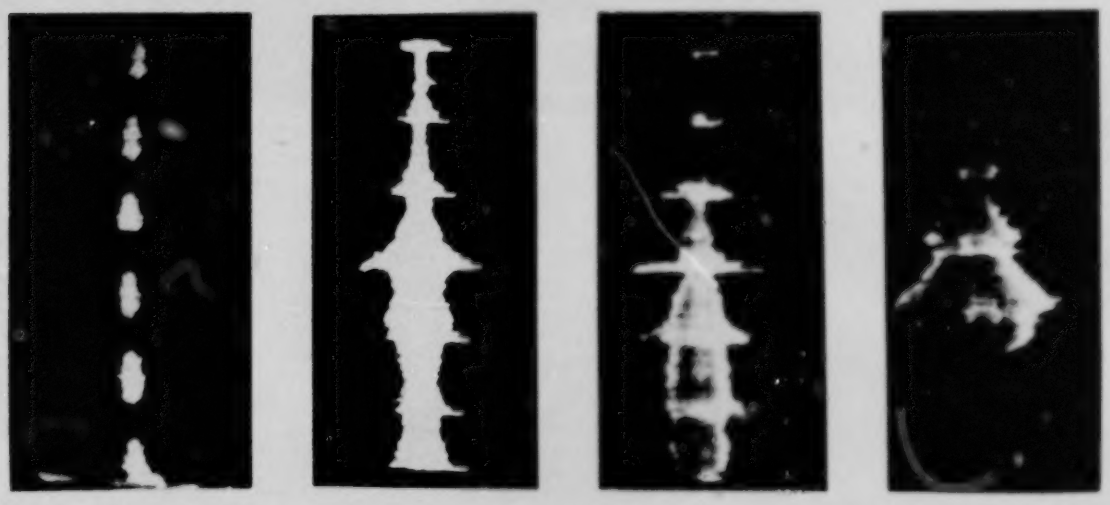
6. (SAWRS) Preparing Sky Cover Height Tables. Prepare sky cover height tables as follows:

a. Compute tables for each ceiling light and ceilometer baseline on the basis of $h = b \times \tan \theta$; where "b" is the baseline, "θ" is the angular reading and "h" is the sky cover height or vertical visibility.

b. Add algebraically the difference between the height of the observation site and the field elevation to each value.

c. Round each of these sums to the reportable height increment listed in paragraph 3.6.2.

d. Separate tables need not be prepared for multiple ceilometer installations with identical baselines when the difference in the height of the projector trunnions (rotation pivots) is less than 10 feet.



(A) (B) (C) (D)

Fig. A3-1 Rotating-Beam Ceilometer -- Examples of cathode ray tube (CRT) presentation of sky-cover reactions, and spurious maxima at 15° intervals. These spurious maxima are caused by nearby, high-intensity flashing runway lights. Note that in case A, only "flasher" interference is visible; in (B) & (C), the superimposed sky-cover return is probably representative of vertical visibility into surface-based obscuring phenomena (the decision should be based on supplementary visual observations); in (D), the sky-cover signal maxima (near 34°) appears to be representative of the base of a sky-cover layer aloft. However, when the maxima occur at a low angle, or the inverted taper of the return, below the maxima, is not pronounced, as it is in this case, it is especially important that the decision be determined on the basis of supplementary visual observations, as well as experience with the equipment.

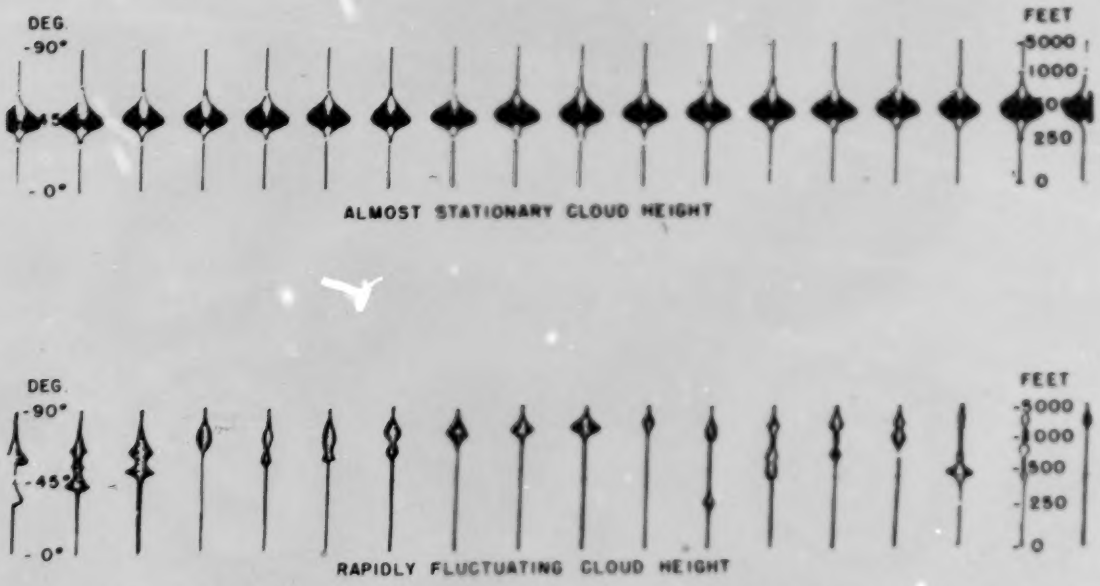


Fig. A3-2 Rotating-Beam Ceilometer -- Examples of cathode ray tube (CRT) presentation of typical sky-cover reactions, free from noise or spurious maxima.

Figure A3-3. Determination of Convective Cloud Base Heights.

EXAMPLE A: Dew-Point Temperature = 34 F. Dry-Bulb Temperature = 65 F. Convective Cloud Height=7000ft.	EXAMPLE C: Dew-Point Temperature = 72 F. Dry-Bulb Temperature = 85 F. Convective Cloud Height=3000ft.
EXAMPLE B: Dew-Point Temperature = 46 F. Dry-Bulb Temperature = 70 F. Convective Cloud Height=5500ft.	EXAMPLE D: Dew-Point Temperature = 58 F. Dry-Bulb Temperature = 75 F. Convective Cloud Height=4000ft.

CONVECTIVE CLOUD-BASE HEIGHT DIAGRAM

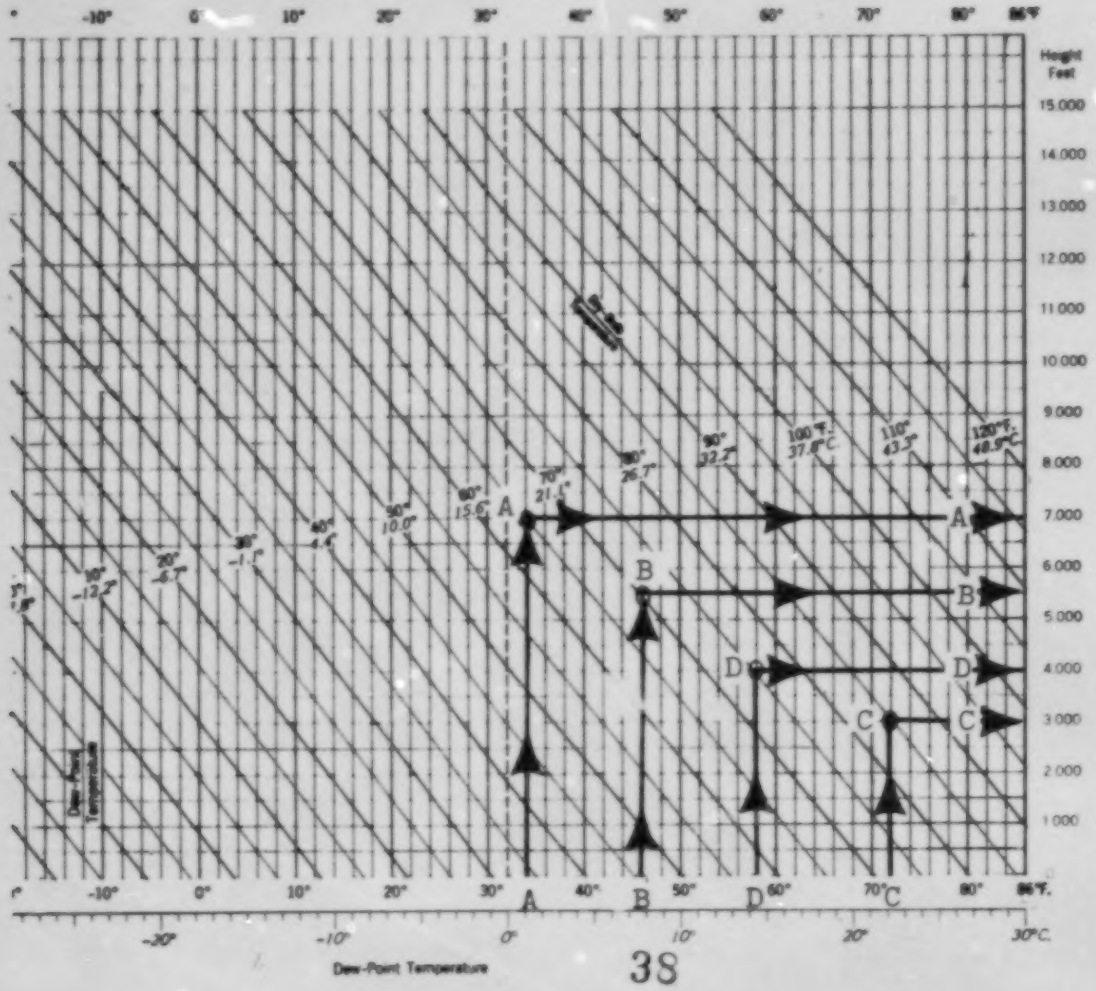


Figure A3-4.

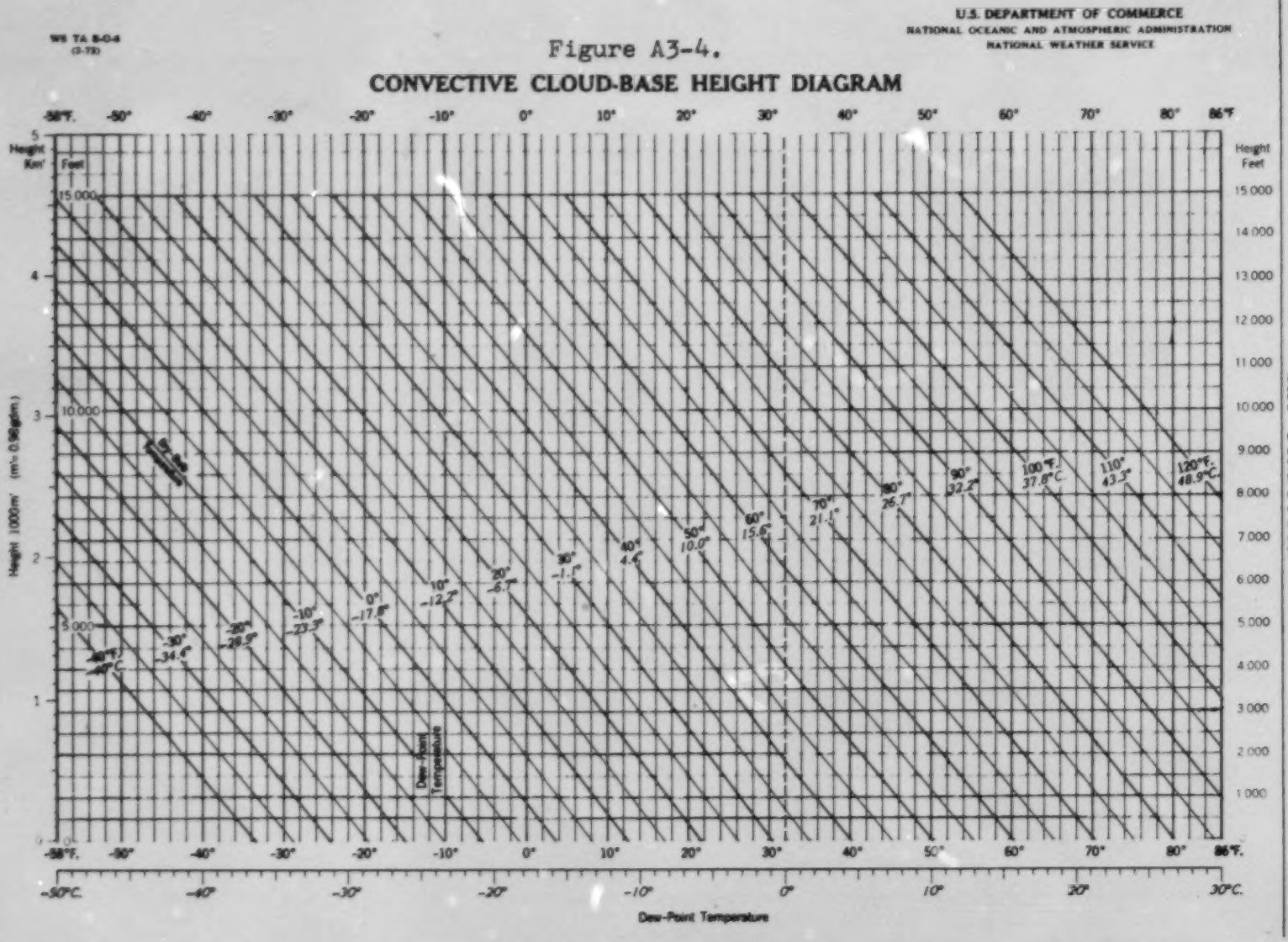


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Figure A3-5. Examples of Summation of Sky Cover

Totally Opaque Sky Cover Layers	Summation	Appropriate Contraction	Sky Cover Entries Col. 3	Col. 13
1) 0.4 sky hidden by fog	0.4	-X /F4		
0.3 sky cover at 1,000 feet	0.7	BKN		
0.2 sky cover at 5,000 feet	0.9	BKN	-X M1Ø BKN 5Ø BKN	F4
2) Less than 0.1 (.02) sky cover at 500 feet	0.0	/STFRA W		
Less than 0.1 (.04) sky cover at 2,000 feet	0.1	SCT		
0.5 sky cover at 3,000 feet	0.6	BKN		
Less than 0.1 sky cover at at 9,000 feet	0.6	BKN	2Ø SCT E3Ø BKN 9Ø BKN	STFRA W
3) 0.6 sky cover at 1,000 feet	0.6	BKN		
0.3 sky cover at 5,000 feet	0.9	BKN		
0.1 sky cover at 30,000 feet (with breaks)	1.0	OVC /BINOVC	M1Ø BKN 5Ø BKN 3ØØ OVC	BINOVC
4) 0.1 sky cover at 1,000 feet (smoke aloft)	0.1	SCT/K1Ø SCT		
0.3 sky cover at 5,000 feet	0.4	SCT		
0.1 sky cover at 35,000 feet	0.5	SCT	1Ø SCT 5Ø SCT 35Ø SCT	K10 SCT
5) 0.2 sky cover at 500 feet	0.2	SCT		
Sky hidden by snow, vertical visibility 1,000 feet	1.0	X	5 SCT W1Ø X	
6) 0.8 sky hidden by fog	0.8	-X /F8		
0.2 sky cover at 500 feet	1.0	OVC	-X M5 OVC	F8

Partly Opaque Sky Cover Layers	Summation Opaque	Summation Total	Ratio Opaque/Total	Appropriate Contraction	Sky Cover Entries Col. 3	Col. 13
7) 0.8 sky cover at 500 feet (0.0 opaque)	0.0	0.8	0/8	-BKN	5 -BKN	
8) 0.1 sky hidden by surface smoke	0.1	0.1	1/1	-X/K1		
0.7 sky cover at 1,000 feet (0.1 opaque)	0.2	0.8	2/8	-BKN	-X 1Ø -BKN	
0.2 sky cover at 5,000 feet (all opaque)	0.4	1.0	4/10	-OVC	5Ø -OVC	K1
9) 0.4 sky cover at 1,000 feet (0.2 opaque)	0.2	0.4	2/4	-SCT		
0.2 sky cover at 2,000 feet (0.2 opaque)	0.4	0.6	4/6	BKN		
0.2 sky cover at 5,000 feet (0.0 opaque)	0.4	0.8	4/8	-BKN		
0.2 sky cover at 9,000 feet (0.2 Opaque)	0.6	1.0	6/10	OVC	1Ø -SCT E2Ø BKN 5Ø -BKN 9Ø OVC	

Table A3-1. Sky Cover Contractions			
Summation Amount of Sky Cover in Tenths	Contractions		Remarks
1/10 to less than 10/10 surface-based obscuring phenomena		-X	No height assigned to this condition. Vertical visibility is not completely restricted.
10/10 surface-based obscuring phenomena		X	Always preceded by a vertical visibility value.
Less than 1/10		CLR	Not used in combination with other contractions. Presence of less than 1/10 clouds indicated in column 13, e.g., ST NW.
1/10 thru 5/10 half or more thin 1/10 thru 5/10 more than half opaque 6/10 thru 9/10 half or more thin	Only used to report layers aloft.	- SCT SCT - BKN	Height values preceding these contractions are never designated as ceiling layers.
6/10 thru 9/10 more than half opaque	Only used to report layers aloft.	BKN	Height value preceding this contraction prefixed with a ceiling layer designator provided a lower ceiling layer is not present.
10/10 half or more thin	Only used to report layers aloft.	- OVC	Height value preceding this contraction is never prefixed with a ceiling layer designator.
10/10 more than half opaque	Only used to report layers aloft.	OVC	Used in combination with lower overcast layers only when such layers are classified as thin. Height value is prefixed with a ceiling designator provided a lower broken ceiling is not present.

Table A3-2. Sky Cover Evaluation

Angle of Advancing or Receding Layer Edge	Tenths of Sky Cover	Angular Elevation of Layer Surrounding Station
0^{o} to 25^{o}	0	0^{o} to 2^{o}
26^{o} to 45^{o}	1	3^{o} to 8^{o}
46^{o} to 59^{o}	2	9^{o} to 14^{o}
60^{o} to 72^{o}	3	15^{o} to 20^{o}
73^{o} to 84^{o}	4	21^{o} to 26^{o}
85^{o} to 95^{o}	5	27^{o} to 33^{o}
96^{o} to 107^{o}	6	34^{o} to 40^{o}
108^{o} to 119^{o}	7	41^{o} to 48^{o}
120^{o} to 134^{o}	8	49^{o} to 58^{o}
135^{o} to 154^{o}	9	59^{o} to 71^{o}
155^{o} to 180^{o}	10	72^{o} to 90^{o}

Table A3-3A. 10-Gram Balloon Ascension Rates*

Nozzle Lift 45-g Helium

Time Minutes and Seconds	Reportable Height	Time Minutes and Seconds	Reportable Height
0:00 - 0:06	0	5:36 - 5:50	2600
0:07 - 0:17	100	5:51 - 6:04	2700
0:18 - 0:30	200	6:05 - 6:18	2800
0:31 - 0:42	300	6:19 - 6:32	2900
0:43 - 0:53	400	6:33 - 6:47	3000
0:54 - 1:06	500	6:48 - 7:01	3100
1:07 - 1:20	600	7:02 - 7:15	3200
1:21 - 1:32	700	7:16 - 7:30	3300
1:33 - 1:45	800	7:31 - 7:44	3400
1:46 - 1:58	900	7:45 - 7:58	3500
1:59 - 2:11	1000	7:59 - 8:12	3600
2:12 - 2:24	1100	8:13 - 8:27	3700
2:25 - 2:37	1200	8:28 - 8:41	3800
2:38 - 2:51	1300	8:42 - 8:55	3900
2:52 - 3:04	1400	8:56 - 9:10	4000
3:05 - 3:17	1500	9:11 - 9:24	4100
3:18 - 3:30	1600	9:25 - 9:38	4200
3:31 - 3:43	1700	9:39 - 9:52	4300
3:44 - 3:56	1800	9:53 - 10:07	4400
3:57 - 4:10	1900	10:08 - 10:21	4500
4:11 - 4:24	2000	10:22 - 10:35	4600
4:25 - 4:38	2100	10:36 - 10:50	4700
4:39 - 4:52	2200	10:51 - 11:04	4800
4:53 - 5:07	2300	11:05 - 11:18	4900
5:08 - 5:21	2400	11:19 - 12:01	5000
5:22 - 5:35	2500	12:02 - 12:02+70sec	5500
		13:13 - 13:13+70sec	6000
		etc.	

*Daytime Use Only.

Table A3-3B. 30-Gram Balloon Ascension Rates*

Nozzle Lift 139-g Helium

Time Minutes and Seconds	Reportable Height	Time Minutes and Seconds	Reportable Height
0:00 - 0:04	0	3:53 - 4:01	2600
0:05 - 0:12	100	4:02 - 4:11	2700
0:13 - 0:20	200	4:12 - 4:21	2800
0:21 - 0:30	300	4:22 - 4:31	2900
0:31 - 0:38	400	4:32 - 4:40	3000
0:39 - 0:46	500	4:41 - 4:50	3100
0:47 - 0:55	600	4:51 - 5:00	3200
0:56 - 1:03	700	5:01 - 5:10	3300
1:04 - 1:12	800	5:11 - 5:20	3400
1:13 - 1:22	900	5:21 - 5:31	3500
1:23 - 1:31	1000	5:32 - 5:41	3600
1:32 - 1:40	1100	5:42 - 5:51	3700
1:41 - 1:50	1200	5:52 - 6:01	3800
1:51 - 1:59	1300	6:02 - 6:11	3900
2:00 - 2:08	1400	6:12 - 6:21	4000
2:09 - 2:17	1500	6:22 - 6:32	4100
2:18 - 2:27	1600	6:33 - 6:42	4200
2:28 - 2:36	1700	6:43 - 6:52	4300
2:37 - 2:45	1800	6:53 - 7:02	4400
2:46 - 2:54	1900	7:03 - 7:12	4500
2:55 - 3:03	2000	7:13 - 7:22	4600
3:04 - 3:13	2100	7:23 - 7:33	4700
3:14 - 3:23	2200	7:34 - 7:43	4800
3:24 - 3:32	2300	7:44 - 7:53	4900
3:33 - 3:42	2400	7:54 - 8:24	5000
3:43 - 3:52	2500	8:25 - 8:25+51sec	5500
		9:17 - 9:17+51sec	6000
		etc.	

*Daytime Use Only.

Table A3-4. Cloud Types and Obscuring Phenomena

(Contractions for Use in Column 13)

CLOUD TYPES	CONTRACTIONS
Altocumulus	AC
Altocumulus castellanus	ACCAS
Altocumulus (standing lenticular)	ACSL
Altostratus	AS
Cirrocumulus	CC
Cirrocumulus (standing lenticular)	CCSL
Cirrostratus	CS
Cirrus	CI
Cumulonimbus mamma (Mammatocumulus)	CBMAM
Cumulus	CU
Cumulus Fractus	CUFRA
Towering Cumulus	TCU
Stratus Fractus	STFRA
Nimbostratus	NS
Stratocumulus	SC
Stratocumulus (standing lenticular)	SCSL
Stratus	ST
OBSCURING PHENOMENA	
Hydrometeors Other than Precipitation	
Blowing snow	BS
Blowing spray	BY
Fog (any form including GF and IF)	F
Lithometeors	
Dust (including BD)	D
Haze	H
Sand (including BN)	N
Smoke	K

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CHAPTER A4

VISIBILITY

1. General.

1.1 All visibilities referred to in this chapter are horizontal visibilities.

2. Definitions.

2.1 Visibility. The greatest distance at which selected objects can be seen and identified.

2.2 Prevailing Visibility. The greatest visibility equaled or exceeded throughout at least half the horizon circle, which need not necessarily be continuous.

2.3 Sector Visibility. The visibility within a specified portion of the horizon circle.

2.4 Variable Prevailing Visibility. A condition when the prevailing visibility rapidly increases and decreases by one or more reportable values during the period of observation.

2.5 Visibility Markers. Dark or nearly dark objects viewed against the horizon sky during the day, or unfocused lights of moderate intensity (about 25 candela) during the night.

3. Observing and Reporting Procedures.

3.1 Unit of Measure. Determine and report visibility in statute miles.

3.2 Observing Aids for Visibility. Post charts, lists, or other positive means of identifying visibility markers near the observing position. At local discretion, separate lists or charts can be used for daytime and nighttime markers. In any case, the markers must be clearly identified as daytime or nighttime markers.

3.3 Observating Sites. Take visibility observations from as many locations as practicable and accessible to view as much of the horizon as possible.

3.4 Selecting Visibility Markers. Insofar as possible, markers of the type described in paragraph 2.5 should be used for determining visibility. The red or green course lights of beacons, TV, and radio tower obstruction lights, etc., may be used as nighttime visibility markers. Because of their intensity, focused lights such as airway beacons may not be used as markers, but their degree of brilliance may be used as an aid to estimate whether the visibility is greater or less than the distance to the light source.

3.5 Dark Adaptation. Before taking visibility observations at night, spend as much time as practicable in the darkness to allow your eyes to become accustomed to the limited light.

3.6 Determining Visibility. Use all available visibility markers to determine the greatest distances that can be seen in all directions around the horizon circle. When the visibility is greater than the distance to the farthest markers, estimate the greatest distance you can see in each direction. Base this estimate on the appearance of the visibility markers. If the markers are visible with sharp outlines and little blurring of color, the visibility is much greater than the distance to the markers. If a marker can barely be seen and identified, the visibility is about the same as the distance to that marker.

3.7 Determining Prevailing Visibility. After visibilities have been determined around the entire horizon circle, resolve them into a single reportable value (see table A4-1). To do this, use either the greatest distance that can be seen throughout at least half the horizon circle, or if the visibility is varying rapidly during the time of the observation, use the average of all observed values.

3.8 Determining Sector Visibility. When the visibility is not uniform in all directions, divide the horizon circle into sectors that have approximately the same visibility. Report only those sectors that differ from the prevailing visibility and are either less than 3 miles or considered operationally significant.

4. Visibility Entries on MF1-10C.

4.1 Prevailing Visibility (Column 4). Enter the prevailing visibility to the nearest reportable value as shown in table A4-1. When entering this value consider the following:

a. Visibility is reported in statute miles.

b. When the prevailing visibility is estimated to be more than the distance of the furthest visibility marker, estimate that visibility to the nearest reportable value.

c. If the visibility is halfway between two reportable values select the lower value.

d. If the visibility is less than 3 miles and rapidly increases and decreases by one or more reportable values, suffix the average of the observed values in column 4 with a V (for variable) and enter the range of variability in Remarks (see paragraph A4-4.2a).

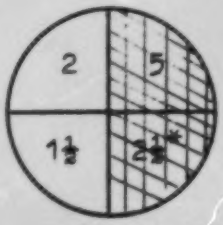
4.1.1 Prevailing Visibility (Column 4a). This column is not used at SAWRS or LAWRS.

4.2 Entries in Column 13.

When condition observed is:	Then enter:
a. Prevailing visibility less than 3 miles varying by one or more reportable values.	"VSBY" followed by extremes of variability separated by "V"; i.e., VSBY 1/4V1/2.
b. Sector visibility less than 3 miles or operationally significant and differing from the prevailing visibility.	"VSBY," sector identification, and visibility in the sector(s); i.e., VSBY N2, VSBY NW2S1/2.

Prevailing visibility indicated by asterisks and cross-hatching.

Four Sectors	
Visibility	Approximate Degree Azimuth
5	90
2 1/2*	90
	180
2	90
1 1/2	90



Five Sectors	
Visibility	Approximate Degree Azimuth
5	100
3*	90
	190
2 1/2	60
2	50
1 1/2	60

Five Sectors	
Visibility	Approximate Degrees Azimuth
5	72
3	72
2 1/2*	72
	216
2	72
1 1/2	72

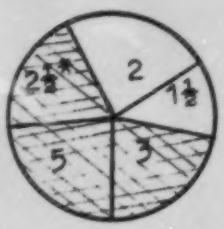


Figure A4-1. Examples - Determination of prevailing visibility.

Table A4-1. Reportable Visibility Values (Miles)

Increments of Separation (Miles)							
1/16	1/8		1/4	1/2	1		5
0	3/8	1 1/4	2	2 1/2	3	10	15
1/16	1/2	1 3/8	2 1/4	3	4	11	20
1/8	5/8	1 1/2	2 1/2		5	12	25
3/16	3/4	1 5/8			6	13	30
1/4	7/8	1 3/4			7	14	35
5/16	1	1 7/8			8	15	40
3/8	1 1/8	2			9		etc.

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CHAPTER A5

ATMOSPHERIC PHENOMENA

1. General.

1.1 Content. This chapter contains instructions for identifying, recording, and reporting atmospheric phenomena.

2. Definitions.

2.1 Meteors. A meteor is a phenomenon, other than cloud, observed in the atmosphere or on the surface. Meteors may consist of precipitation, suspensions or deposits of liquid water, frozen water, or other particulate matter, or optical or electrical manifestations. Meteors discussed in this chapter are hydrometeors, lithometeors, and electrometeors.

2.2 Hydrometeors. Hydrometeors are liquid or solid water particles that are either falling through or suspended in the atmosphere, blown from the surface by wind, or deposited on objects. The most common hydrometeors are defined below.

2.2.1 Rain (R). Precipitation of liquid water particles, either in the form of drops larger than 0.02 inch (0.5 mm) or smaller drops which, in contrast to drizzle, are widely separated.

2.2.2 Freezing Rain (ZR). Rain that freezes upon impact with the ground or with objects in flight or on the ground.

2.2.3 Drizzle (L). Fairly uniform precipitation composed exclusively of fine drops (diameter less than 0.02 inch or 0.5 mm) very close together.----Drizzle appears to float while following air currents, although unlike fog droplets, it falls to the ground. Drizzle drops are too small to appreciably disturb, still water puddles.

2.2.4 Freezing Drizzle (ZL). Drizzle that freezes upon impact with the ground or with objects in flight or on the ground.

2.2.5 Snow (S). Precipitation of ice crystals, mostly branched in the form of six pointed stars.----At temperatures higher than about 23°F, the crystals are generally clustered to form snowflakes.

2.2.6 Snow Pellets (SP). Precipitation of white opaque grains of ice. The grains are round or sometimes conical. Diameters range from about 0.08 to 0.2 inch.----Snow pellets are brittle and easily crushed. When they fall on hard ground they bounce and often break up.

2.2.7 Snow Grains (SG). Precipitation of very small, white, opaque grains of ice.----When the grains hit hard ground, they do not bounce or shatter. They usually fall in small quantities, mostly from stratus clouds and never as showers.

2.2.8 Ice Pellets (IP). Precipitation of transparent or translucent pellets of ice, which are round or irregular, rarely conical, and which have a diameter of about 0.2 inch (5 mm).----The pellets usually rebound when striking hard ground and make a sound on impact. There are two main types:

a. Hard grains of ice consisting of frozen raindrops or largely melted and refrozen snowflakes (formerly sleet).----This type falls as continuous or intermittent precipitation.

b. Pellets of snow encased in a thin layer of ice formed from the freezing either of droplets intercepted by the pellets or of water resulting from the partial melting of the pellets.----Ice Pellets of this type fall as showers.

2.2.9 Hail (A). Precipitation of small balls or other pieces of ice, (hail stones) falling separately or frozen together in irregular lumps.----Hailstones consist of alternate opaque and clear layers of ice in most cases. Hail is normally associated with thunderstorms and surface temperatures above freezing.

2.2.10 Ice Crystals (IC). A fall of unbranched crystals of ice in the form of needles, columns, or plates. These are often so tiny that they seem to be suspended in the air. They may fall from a cloud or from clear air.----Ice crystals are visible mainly when they glitter in the sunshine or other bright light. They may then produce a luminous pillar or other optical phenomena. This hydrometeor (rarely more than the lightest precipitation), which is frequent in polar regions, occurs only at very low temperatures in stable air masses.

2.2.11 Fog (F) and Ground Fog (GF). A visible aggregate of minute water particles (droplets) that are based at the earth's surface.

a. Fog reduces horizontal and vertical visibility and may extend over a sizable area. In Aviation observations, Fog is reported when the depth of the phenomena is greater than approximately 20 feet.

b. Ground Fog has little vertical extent (normally less than 20 feet) and reduces visibility horizontally but to a lesser extent vertically. When present, the stars may often be seen at night and the sun during the day. This is a local phenomena usually formed by radiation cooling of the air. It is often patchy, forming first in low lying areas.

c. When fog is present and the occurrence does not clearly fit the definition of Ground Fog, the phenomena will be reported as Fog.

2.2.12 Ice Fog (IF). A suspension of numerous minute ice crystals in the air, based at the earth's surface and, reducing horizontal visibility.----Unlike Fog, Ice Fog does not produce rime or glaze on cold exposed objects. Temperatures are usually at or below -20 degrees Fahrenheit when Ice Fog forms. However, a mixture of liquid and ice fog occasionally forms at temperatures below freezing. This condition may persist for a few hours as the fog changes to Ice Fog and dissipates due to a drying of the air, even though temperatures continue to fall. Optical effects similar to those associated with Ice Crystals are observed in Ice Fog. Temperature-dew point differences may exceed 8 degrees Fahrenheit.

2.2.13 Drifting Snow and Blowing Snow. Snow particles raised from the ground by a strong turbulent wind.

a. DRIFTING SNOW. Snow particles raised by the wind to small heights above the ground.----Visibility is not reduced below 7 miles at eye level (6 feet) although obstructions below this level may be veiled or hidden by the particles moving nearly horizontal to the ground.

b. BLOWING SNOW (BS). Snow particles raised and stirred violently by the wind to moderate or great heights.----Visibility is poor (6 miles or less) and the sky may become obscured when the particles are raised to great heights.

2.2.14 Spray and Blowing Spray.

a. SPRAY. Water droplets torn by the wind, generally from the crests of waves, and carried up a short distance into the air.

b. BLOWING SPRAY (BY). Spray raised in such quantities as to reduce the visibility at eye level (6 feet) to 6 miles or less.

2.2.15 Rime. A deposit of ice, produced by Fog at temperatures below 32 degrees Fahrenheit. It is composed of grains separated by air, sometimes adorned with crystalline branches.

2.2.16 Glaze. A coating of ice, generally clear and smooth, but with some air pockets. It is formed on exposed objects at temperatures below or slightly above 32 degrees Fahrenheit by the freezing of super-cooled drizzle or rain drops. Glaze is denser, harder, and more transparent than Rime.

2.2.17 Funnel Cloud. A violent rotating cone-shaped column of air not touching the ground and usually suspended from a cumulonimbus cloud.

2.2.18 Tornado. A violent rotating cone-shaped column of air touching the ground and usually suspended from a cumulonimbus cloud. It nearly always starts as a funnel cloud and makes a loud roaring noise.

2.2.19 Waterspout. A tornado which forms over a body of water and touches the water surface.

2.3 Lithometeors. A lithometeor is a meteor consisting of a visible concentration of mostly solid, dry particles. The particles are more or less suspended in the air or lifted from the ground by wind. The more common lithometeors are defined below.

2.3.1 Haze (H). A suspension in the air of extremely small, dry particles invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance. ----This phenomenon resembles a uniform veil over the landscape that subdues all colors. Dark objects viewed through this veil tend to have a bluish tinge while bright objects such as the sun or distant lights, tend to have a dirty yellow or reddish hue. When haze is present and the sun is well above the horizon it's light may have a peculiar silvery tinge. Haze particles are generally well diffused through the atmosphere and may be composed of a variety of substances; e.g., dust, salt, residue from distant fires or volcanoes, pollen, etc.

2.3.2 Dust (D). Fine particles of dust or sand suspended in the air by a duststorm or sandstorm that may have occurred either at the station or far away from the station.---- Dust gives a tan or gray tinge to distant objects. The sun's disk is pale and colorless or has a yellow tinge through dust.

2.3.3 Smoke (K). A suspension in the air of small particles produced by combustion.----This phenomenon may be present either near the earth's surface or in the free atmosphere. When viewed through smoke, the disk of the sun at sunrise and sunset appears very red. The disk may have an orange tinge when the sun is above the horizon. Evenly distributed smoke from distant sources generally has a light grayish or bluish appearance. A transition to haze may occur when smoke particles have traveled great distances, 25 to 100 miles or more, and when the larger particles have settled out and the remaining particles have become widely scattered through the atmosphere.

2.3.4 Dust Devil. A small, vigorous whirlwind, usually of short duration, made visible by dust picked up from the surface.

2.3.5 Blowing Dust (BD). Dust raised by the wind to moderate heights above the ground and restricting horizontal visibility to less than 7 miles.

2.3.6 Blowing Sand (BN). Sand raised by the wind to moderate heights above the ground reducing horizontal visibility to less than 7 miles.

2.4 Electrometeors. An electrometeor is a visible or audible manifestation of atmospheric electricity. The more important electrometeors are defined below:

2.4.1 Thunderstorm (T). A local storm produced by a cumulonimbus cloud. It is always accompanied by lightning and thunder, usually with strong gusts of wind, heavy rain, and sometimes with hail.

2.4.2 Lightning. A flash of light from a sudden electrical discharge that takes place from or inside a cloud or from high structures on the ground or from mountains.----Four main types of lightning can be distinguished:

a. CLOUD TO GROUND LIGHTNING (CG). Lightning occurring between cloud and ground.

b. CLOUD DISCHARGES (IC). Lightning that takes place within the thunder cloud.

c. CLOUD TO CLOUD DISCHARGES (CC). Streaks of lightning reaching from one cloud to another.

d. AIR DISCHARGES (CA). Streaks of lightning that pass from a cloud to the air, but do not strike the ground.

2.5 Character of Precipitation. The character of precipitation is either continuous, intermittent, or showery.

2.5.1 Continuous. Intensity changes gradually, if at all.

2.5.2 Intermittent. Intensity changes gradually, if at all, but precipitation stops and starts at least once within the hour preceding the observation.

2.5.3 Showery. Precipitation changes intensity, or starts and stops abruptly. Showers fall from cumuliform clouds.

2.6 Precipitation Intensity. Precipitation intensity indicates the amount of precipitation falling at the time of observation. It is expressed as light, moderate, or heavy and is defined with respect to the type of precipitation occurring. Criteria based on time (duration) does not accurately describe the intensity at the time of observation. For this reason tables A5-2 and A5-3 should only be used as a guide to estimate the intensity at the time of observation. Table A5-1, on the other hand, is based on the visibility at the time of observation and must be used to determine intensity of drizzle or snow if either is occurring alone. If snow or drizzle are present with other obscuring phenomena, table A5-1 should only be used as a guide when intensity is determined.

3. Reporting Precipitation. Enter precipitation occurring at the station in column 5 of MF1-10C using the symbols and order (i.e., Tornadic activity, Thunderstorm, liquid, freezing, frozen precipitation) shown in table A5-5. Intensity symbols are shown in table A5-4.

3.1 Tornado, Waterspout, Funnel Cloud. A Special observation is required whenever these phenomena are observed to begin and/or disappear. This report may be a single-element Special. If known, the report will contain the following:

a. Type of phenomenon (spelled out) in columns 5 and 13.

b. Location with respect to station or with reference to a well-known point (show distance in nautical miles) in column 13.

c. Direction toward which the phenomenon is moving. If this is unknown, enter MOVMT UNKN in column 13.

d. Examples of entries in column 13:

When condition observed is:	Then enter:
1. Tornado, funnel cloud, or waterspout in progress at station.	Description, distance, if known, and direction from station, and direction of movement; i.e., TORNADO NE MOVG N, FUNNEL CLOUD S MOVMT UNKN.
2. Tornado, funnel cloud, or waterspout has ended or disappeared.	Description and direction of movement; i.e., TORNADO MOVD N, FUNNEL CLOUD NW DSIPTD.

3.2 Thunderstorm.

3.2.1 Beginning of Thunderstorm. A thunderstorm is considered to begin at a station when:

a. Thunder is heard, or

b. Overhead lightning or hail is observed and the local noise level might prevent hearing thunder.

3.2.2 Ending of Thunderstorm. A thunderstorm is considered to have ended 15 minutes after the last occurrence of any of the criteria in paragraph 3.2.1.

3.2.3 Intensity of Thunderstorms. The intensity of a thunderstorm is based on the following characteristics observed within the previous 15 minutes:

a. Thunderstorm (T), wind gust less than 50 knots and hail, if any, less than 3/4 inch in diameter.

b. Severe Thunderstorm (T+), wind gusts of 50 knots or greater or hail 3/4 inch or greater in diameter.

3.2.4 Reporting Thunderstorms. A Special observation is required when a thunderstorm begins, ends, or increases in intensity. The report should include the following as remarks:

a. T or T+.

b. Location and distance (if known) of each storm center with respect to the station.

c. Direction toward which the storm is moving. Omit if unknown.

d. Type of lightning.

e. Examples of entries in column 13.

When condition observed is:	Then enter:
Thunderstorm in progress	Distance from station (if known), direction from station, and movement (if known); i.e., T W MOVG E.
Thunderstorm ending	"T," and direction of movement; i.e., T MOVD E.
Lightning	Frequency, type, and direction from station. Direction may be omitted if the same as T or CB/CBMAM remark; i.e., OCNL LTGCCCG N, FQT LTGCAIC SE-NW.

3.2.5 Reporting Hail. A Special observation is required when Hail begins or ends. No intensity symbol is used with Hail but all observations concerning it shall report the diameter (units and fractions of inch) of the largest stones in Remarks, column 13; e.g., HLSTO 1/2.

3.3 Reporting Precipitation. Precipitation of any form is reported in the body of a weather report (column 5) whenever it is observed to be occurring at the station. Precipitation observed at a distance from the station may be reported in Remarks (column 13).

3.3.1 Observing Precipitation. In order to adequately report and document precipitation, the following statistics should be determined:

a. Type,

b. Character,

c. Intensity.

3.3.2 Determining and Reporting Type of Precipitation. Determine the type of precipitation in accordance with the definitions in section 2 of this chapter. Report precipitation using the symbols and order (liquid, freezing, frozen) shown in table A5-5. A Special observation is required whenever freezing precipitation or Ice Pellets begin, end, or change intensity.

3.3.3 Determining the Character of Precipitation. The character of the precipitation is determined by using the definitions in paragraph 2.5.

3.3.4 Determining the Intensity of Precipitation. Use tables A5-1, 2, and 3 to determine the intensity of precipitation (see paragraph 2.6).

a. Use table A5-1 to determine intensity if any of the following types of precipitation are occurring alone: Drizzle (L); Freezing Drizzle (ZL); Snow (S); Snow Grains (SG); Snow Pellets (SP).

b. If any of these are occurring with other types of precipitation or obstructions to vision use table A5-1 only as a guide to estimate intensity. The intensity will be no greater than determined using visibility for criteria if any of the above were occurring alone. For example, S+ with or without other phenomena cannot be reported if the visibility is greater than or equal to 5/16 of a mile; S with or without other phenomena cannot be reported if the visibility is 5/8 of a mile or more.

c. Use table A5-2 as a guide to estimate the intensity of Ice Pellets.

d. Use table A5-3 as a guide to estimate the intensity of Rain or Freezing Rain.

3.3.4.1 Reporting Intensity. Report the intensity of precipitation using the symbols in table A5-4. No intensity symbol is used with Hail or Ice Crystals.

3.4 Significant Remarks Concerning Weather.

Observed:	Reported Entry:
a. Precipitation varying in intensity during the period of observation.	Type and intensity (as reflected in column 5), "OCNLY," and type and intensity to which it varied during the period of observation; i.e., R- OCNLY R, SW OCNLY SW-.
b. Precipitation at a distance from (but not at) the station.	Type and intensity (or "U" if unknown), and direction from station; i.e., RWU NW, S OVR MTNS N.
c. Intermittent precipitation having occurred within the past 15 minutes or occurring at observation time.	Type and intensity; i.e., INTMT R-.
d. Showers having occurred within the past 15 minutes, but not occurring at observation time.	Frequency of showers, type, and intensity; i.e., OCNL RW.
e. Wet snow (snow that contains a great deal of liquid).	WET SNW.

4. Reporting Obstructions to Vision. Include obstructions to vision in the body of a report (column 5) only if prevailing visibility is reduced to less than 7 miles and the obstruction is present at the station. If the visibility is reduced to less than 7 miles by an obstruction at a distance from the station, the phenomenon is described in Remarks (column 13). If more than one type of obstruction to vision is present report them in order of decreasing predominance.

4.1 Operationally Significant Remarks for Obstructions to Vision. Any occurrence of an obstruction to vision which in the opinion of the observer is operationally significant, and is not reported elsewhere in the observation, should be clearly reported in Remarks. Some examples of desirable items to be entered in Remarks are as follows.

	Observed:	Entry:
a.	Fog dissipating or increasing.	F DSIPTG or F INCRG
b.	Smoke drifting over field.	K DRFTG OVR FLD
c.	Shallow ground fog (height less than 6 feet).	"SHLW GF" followed by "DEP" and depth in feet, if known; e.g., SHLW GFDEP4.
d.	Drifting snow (height less than 6 feet).	"DRFTG SNOW." This phenomena is recorded, when observed, only if blowing snow is not being reported.
e.	Dust devils.	DUST DEVILS followed by directions from station; e.g., DUST DEVIL SW.
f.	Obscuring phenomena at a distance from and not at the station.	Enter type, description, and direction from the station; e.g., F BANK N-S.

Table A5-1. INTENSITY OF DRIZZLE OR SNOW WITH VISIBILITY AS CRITERIA	
Light	Visibility 5/8 statute mile or more.
Moderate	Visibility less than 5/8 statute mile but not less than 5/16 statute mile.
Heavy	Visibility less than 5/16 statute mile.

Table A5-2. ESTIMATING THE INTENSITY OF ICE PELLETS	
Light	Few pellets falling with little, if any, accumulation
Moderate	Slow accumulation.
Heavy	Rapid accumulation.

Table A5-3. ESTIMATING THE INTENSITY OF RAIN	
Light	Scattered drops that do not completely wet an exposed surface, regardless of duration, to a condition where individual drops are easily seen; slight spray is observed over pavements; puddles form slowly; sound on roofs ranges from slow pattering to gentle swishing; steady small streams may flow in gutters and downspouts.
Moderate	Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces, puddles form rapidly; downspouts on buildings seen 1/4 to 1/2 full; sound on roofs ranges from swishing to gentle roar.
Heavy	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces; downspouts run more than 1/2 full; visibility is greatly reduced; sound on roofs resembles roll of drums or distant roar.

TABLE A5-4. Precipitation Intensity Symbols.	
+	Heavy
-	Light
Absence of symbol indicates moderate	
No intensity is assigned to hail, or ice crystals.	

Table A5-5. Symbols for Weather and Obstructions to Vision			
Weather			
TORNADO WATERSPOUT FUNNEL CLOUD	always written out in full	Freezing Drizzle	ZL
		Ice Pellets	IP
		Ice Pellet Showers	IPW
Severe Thunderstorm	T+	Snow	S
Thunderstorm	T	Snow Showers	SW
Rain	R	Snow Pellets	SP
Rain Showers	RW	Snow Grains	SG
Drizzle	L	Ice Crystals	IC
Freezing Rain	ZR	Hail	A
Obstructions to Vision			
F	Fog	IF	Ice Fog
GF	Ground Fog	H	Haze
BS	Blowing Snow	K	Smoke
BN	Blowing Sand	D	Dust
BD	Blowing Dust	BY	Blowing Spray

1. Combinations of these symbols are entered in the following order:
   a. TORNADO, FUNNEL CLOUD, or WATERSPOUT
   b. Thunderstorm
   c. Liquid precipitation, in order of decreasing intensity
   d. Freezing precipitation, in order of decreasing intensity
   e. Frozen precipitation, in order of decreasing intensity
   f. Obstructions to vision, in order of decreasing predominance, if discernible.
2. Obstructions to vision are reported only when the prevailing visibility at the station is less than 7 miles. Report the phenomena in column 5 if occurring at the station or, if not at the station, in column 13, Remarks. Intensity symbols are not used with obstructions to vision.

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CHAPTER A6

PRESSURE

1. General. Instructions in this chapter apply to routine pressure determinations.

2. Definitions.

2.1 Altimeter Setting (QNH). That pressure value to which an aircraft altimeter scale is set so that it will indicate the altitude above MSL of the altimeter in an aircraft on the ground at the location for which the value was determined.

2.2 Atmospheric Pressure. The pressure exerted by the atmosphere at a given point.

2.3 Field Elevation (H_a). The officially designated field elevation of an airport above mean sea level. It is the elevation of the highest point on any of the runways of the airport.

3. Observing and Recording Procedures.

3.1 Obtaining Altimeter Setting. Altimeter setting values must be obtained from an Altimeter-Setting Indicator or an aircraft-type altimeter that is routinely compared with a mercury barometer or aneroid device.

3.2 Altimeter Setting from Altimeter-Setting-Indicators (ASI). Read the Altimeter-Setting Indicator as follows:

a. Tap the face of the instrument lightly with the finger to reduce the effect of friction on the pointer mechanism.

b. Read the pressure scale of the indicator at the pointer, to the nearest 0.005 inch.

c. Record the lowest altimeter setting (if more than one is available) determined by:

(1) (SAWRS) Algebraically adding the posted correction to the reading and rounding the sum to the nearest inch and hundredths of inches.

(2) (LAWRS) Rounding the reading to inches and hundredths of inches. No correction is required if the instrument is determined reliable by daily comparisons (paragraph 3.2.1).

3.2.1 (LAWRS) Determining the Reliability of Altimeter-Setting Indicators. LAWRS will verify the reliability of each altimeter-setting indicator (ASI) daily as follows:

a. Compare the reading of the ASI with the altimeter setting obtained from an adjacent FSS or NWS office (WSO) meeting the criteria of paragraph 3.2.2, or a mercury barometer at the facility.

b. If the difference between altimeter settings does not exceed .02 inch at precision approach locations or .05 inch at non-precision approach locations the ASI is considered reliable.

(1) When two ASIs are reliable, use the reading which is closer to that obtained from the mercury barometer or adjacent facility. When readings are equidistant use the lower value as altimeter setting.

(2) If only one ASI is reliable, use it to determine altimeter setting.

(3) If both ASIs are unreliable use the altimeter setting obtained from a mercury barometer at the airport. If a mercury barometer is not available, report the altimeter setting missing.

c. Report unreliable instruments and instruments which exceed the stated limits to maintenance personnel.

3.2.2 Comparisons with a Mercury Barometer at an Adjacent Station. Locations without a mercury barometer may compare their altimeter device against values obtained from an adjacent Weather Service Office or Flight Service Station provided:

a. At locations where precision approaches are conducted, the weather station is not more than 10 NM away and the wind speed is 25 knots or less at both locations.

b. At locations conducting non-precision approaches the distance must not exceed 25 NM and the wind speed must be 30 knots or less at both locations.

c. Comparisons are not made when the elevation difference exceeds 1,000 feet.

Do not use altimeter-setting values from aneroid instruments when the difference exceeds .05 inches at non-precision approach locations and .02 at precision approach locations.

3.3 (SAWRS) Aircraft-Type Altimeters. Altimeter settings may also be obtained from aircraft-type altimeters. When used for this purpose the altimeter must be installed and calibrated in accordance with FAA Advisory Circular 91-14B upon which the instructions in this chapter are based.

3.3.1 (SAWRS) Altimeter Settings from Aircraft-Type Altimeters. Use the following procedures to obtain the altimeter setting from an aircraft-type altimeter.

a. Turn the knob of the altimeter until the hands indicate the actual height of the instrument (MSL) or the posted scale setting when one has been determined for the altimeter. Apply any correction required by the correction card.

b. Tap or vibrate the altimeter while resetting it to eliminate any lag due to friction in the mechanism.

c. Recheck the setting after vibration, and reset if necessary.

d. Read the altimeter setting to the nearest 0.01 inch from the pressure scale in a small window in the face of the altimeter.

e. When two aircraft-type altimeters are used, read both instruments at the same time and use the lowest reading as the altimeter setting.

3.3.2 (SAWRS) Comparison of Aircraft-Type Altimeters On-Station. When two aircraft-type altimeters are used, adjust both instruments to the posted elevation-scale value and determine the altimeter setting on each instrument. If the difference between them exceeds 0.05 inch, discontinue use of the instruments and report the altimeter setting missing. Once every day on which observations are made, record the comparison between the two instruments in block 90 of MF1-10C (see paragraph 6.2.1). If only one instrument is used and it is not compared with a mercury barometer it must be compared with:

a. The altimeters in an aircraft parked on a ramp adjacent to the weather office. (See paragraph 3.3.3), or

b. The altimeter at a WSO or FSS office meeting distance, elevation, and wind criteria. (See paragraph 3.2.2.)

3.3.3 (SAWRS) Altimeter-Setting Indicator Comparisons. At locations having two altimeter-setting indicators (ASI) the instruments are compared daily. The instruments are considered reliable if the difference in readings does not exceed .05 inches at non-instrument approach locations. The instrument having the lowest reading will be used to obtain the reported altimeter setting. Report the altimeter setting missing if the limits are exceeded.

3.3.4 (SAWRS) Comparison Between Aircraft-Type Altimeters in the Station and in Aircraft. With this type of comparison the aircraft used must be maintained under the provisions of FAR Part 121. Make comparisons at least three times a week, or daily, if an aircraft is available. Use the following procedure.

a. Determine the altimeter setting in the station using the procedure outlined in paragraph 3.3.1.

b. With the aircraft altimeters set to indicate their actual elevation (MSL), determine the pressure scale reading of both the Captain's and First-Officer's altimeters to the nearest 0.01 inch. Determine the mean of these two readings.

c. Compare the aircraft's mean altimeter setting with the reading of the station's altimeter.

d. Log the difference between the station altimeter and the mean of the aircraft's altimeters in block 90 of MF1-10C each time the comparison is made. (See paragraph 6.2.2.)

If the difference between the mean aircraft reading and the station reading exceeds 0.04 inch, report the altimeter setting missing until a future comparison shows the difference to be 0.04 inch or less. If the difference exceeds 0.04 inch on two successive comparisons, the altimeter must be recalibrated before further use.

4. Obtaining Altimeter Setting from Mercury Barometers. The barometer should be maintained in a vertical position in accordance with applicable instructions.

4.1 Temperature. Read the thermometer, attached to the barrel of the mercury barometer, to the nearest 0.5 degrees Fahrenheit.

4.2 Adjusting the Cistern. Turn the thumbscrew at the bottom of the barometer until the surface of the mercury in the cistern touches the tip of the ivory point (i.e., until the tip coincides with its image in the mercury). If a dimple forms on the surface, the mercury has been raised too far. Contact of the mercury with the ivory point is seen more easily against a white background. After adjusting the cistern:

(1) Tap the barrel near the top of the mercury column.

(2) Set the vernier so that the base just cuts off light at the highest point of the meniscus (the curved upper surface of the mercury column). A white background facilities this setting.

(3) Lower the mercury about 1/4 inch from the ivory point; do not change the setting of the vernier.

4.3 Reading. Read the barometer to the nearest 0.001 inch.

4.4 Total Correction. Add the total correction algebraically to the reading obtained in paragraph 4.3 to obtain station pressure. Compute altimeter setting from station pressure by use of a pressure reduction computer, reduction constant or table. The total correction consists of:

a. The sum of corrections from the barometer correction card.

b. The temperature correction.

4.5 Altimeter Setting from Uncorrected Mercury Barometer Readings. At designated facilities, tables supplied by NWS Regional Headquarters, can be used to obtain altimeter setting values from the uncorrected reading of the mercury barometer (paragraph 4.3) and the temperature of the mercury column (paragraph 4.1.).

5. Comparing Aneroid Instruments with a Mercury Barometer.

5.1 General. At locations with a mercury barometer, aneroid barometers and altimeter-setting indicators will be routinely compared with the mercury barometer to check continued reliability. Comparison data will be entered on MF1-13, using the guide for preparation on the reverse of the form. At locations where mercury barometers are not installed, periodic comparisons of aneroid instruments are made in accordance with table A6-1 and referenced instructions. When there is doubt as to the accuracy or reliability of the station mercury barometer, the person in charge of the station should notify the appropriate headquarters or shop and ask that a comparison be made.

5.2 Unreliable Performance of Aneroid Instruments. Rapid changes of temperature, or exposure to direct heat or sunlight, may cause erratic performance of aneroid instruments. Jarring of instruments may dislocate elements of the linkage system. Excessive friction or leaking pressure cells may result in erroneous pressure readings. After verification of erratic or excessive corrections which exceed the limits given in the following paragraph, discontinue use of the unreliable instrument and notify the appropriate headquarters or maintenance shop. However, questionable corrections noted infrequently at the time of strong gusty winds should be disregarded.

6. Entries on MF1-10C.

6.1 Altimeter Setting (Column 12). Enter in inches of mercury using only the units, tenths, and hundredths digits (without the decimal point); e.g., 29.87 entered 987, 30.21 entered 021.

6.2 Comparison Values. Depending on the method used to compare aneroid devices, make entries in block 90 as described in the following paragraphs. LAWRS will enter their comparisons on MF1-13.

6.2.1 (SAWRS) Altimeter Setting from Two Aneroid Instruments. At stations determining altimeter setting values from the lowest pressure reading of two aneroid devices, neither located in an aircraft, enter, each day on which observations are taken:

a. The reading of each instrument,

b. Difference between the readings, and

c. The time of reading (GMT),

d. Example:

ALTIMETERS, INST #1 29.32, INST #2 29.33, DIFF .01 1330

6.2.2 (SAWRS) Comparison of Aircraft-Type Altimeters in Station with Aircraft's Altimeter. Enter the following when an aircraft-type altimeter is compared with the altimeter in an aircraft.

a. The reading of the station altimeter,

b. The mean of the altimeters (pilot's and co-pilot's) in aircraft,

c. The difference between station's and mean aircraft altimeter setting,

d. The time of comparison (GMT),

e. Example:

Altimeters: Station 29.95, Aircraft's mean 29.94, DIFF -.01, 1230

6.3 Disposition of MF1-13. Retain forms on station until all lines on the form (28) are completed. Mail completed form to the office designated by National Weather Service Regional Headquarters.

Table A6-1. Daily Comparison of Aneroid Devices

Instruments Compared	Difference Must Not Exceed:	Determining the Altimeter Setting
(LAWRS) Each of two Altimeter Setting Indicators (ASIs) compared with the altimeter setting obtained from an adjacent NWS or FSS meeting criteria of paragraph 3.2.2, or a mercury barometer at the facility (paragraph 3.2.1).	.05 inch at non-precision or .02 inch at precision approach locations.	If both ASIs are within limits, use the ASI reading which differs least from the obtained altimeter setting. If differences are equal, use the ASI with the lower reading for altimeter setting. If only one ASI is within limits, use it to determine altimeter setting. If both ASIs exceed limits, use the mercury barometer at the airport to determine altimeter setting. If a mercury barometer is unavailable, report altimeter setting missing.
(SAWRS) Two ASIs or two aircraft-type altimeters located in an office. Compare Instrument #1 and #2 (paragraphs 3.3.2 and 3.3.3).	.05 inch at non-precision or .02 inch at precision approach locations.	If the difference is within limits, use the instrument with the lower reading for the altimeter setting. If the difference exceeds limits, report the altimeter setting missing.
(SAWRS) One aircraft-type altimeter or one ASI compared with the altimeter setting from an adjacent WSO or FSS meeting criteria of paragraph 3.2.2 or a mercury barometer (paragraph 3.3.2).	.05 inch at non-precision or .02 inch at precision approach locations.	If the difference exceeds limits, report the altimeter setting as missing.
(SAWRS) One aircraft-type altimeter compared with mean value of the two altimeters (pilots and copilot's) in an aircraft parked on the ramp adjacent to the weather office (paragraph 3.3.4).	.04 inch at non-precision approach locations.	If the difference exceeds limits, report the altimeter setting as missing.

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CHAPTER A7

TEMPERATURE AND HUMIDITY

1. General. Fahrenheit temperatures are used in this chapter. Dew point is calculated with respect to water at all temperatures. Dew-point temperature is required only if terminal forecasts are prepared for the station.

2. Definitions.

2.1 Temperature.

2.1.1 Dry-Bulb. Ambient temperature registered by a dry-bulb thermometer.

2.1.2 Wet-Bulb. The temperature air would have if cooled to saturation at constant pressure by evaporating water into it.

2.1.3 Dew Point. The temperature at which the air becomes saturated when cooled at constant pressure and constant water-vapor content.

2.2 Wet-Bulb Depression. The difference between the wet-bulb and dry-bulb temperatures.

Dry-Bulb	Wet-Bulb	Wet-Bulb Depression
70	55	15
20	-2	22

2.3 Psychrometer. An instrument used for measuring the water-vapor content of the air. It consists of two ordinary glass thermometers. The bulb of the wet-bulb thermometer is covered with a clean muslin wick which is saturated with water prior to an observation. When the bulbs are properly ventilated, they indicate the wet- and dry-bulb temperatures of the atmosphere.

2.4 Psychrometric Calculator. A circular slide rule used to compute the temperature of the dew point from known values of wet- and dry-bulb temperature at the station's normal atmospheric pressure. Instructions for the use of this calculator are printed on it.

2.5 Psychrometric Tables. Tables prepared from a psychrometric formula and used to obtain the temperature of the dew point from known values of wet- and dry-bulb temperature.

2.6 Sling Psychrometer. A psychrometer which is ventilated by whirling the thermometers with a handle and a swivel link until the maximum wet-bulb depression has been obtained.

2.7 Hygrothermometer. An instrument using remoted sensors obtain dew point and ambient air temperatures. Dial indicators show temperatures. The ambient air temperature dial may have pointers for determining maximum and minimum temperature.

2.8 Instrument Shelter. A boxlike structure designed to protect thermometers from exposure to direct sunshine, precipitation, and condensation, while at the same time providing adequate ventilation.

3. Observing and Reporting Procedures.

3.1 Station Standard System. Use the first available operative system of the following for obtaining temperature and/or psychrometric data.

a. Hygrothermometer.

b. Psychrometer.

3.2 Hygrothermometer.

3.2.1 Operating Range.

a. Temperature: -50 degrees to 120 degrees Fahrenheit.

b. Dew Point: -20 to 80 degrees Fahrenheit.

3.2.2 Evaluating Data. If data is within the operating range of the hygrothermometer obtain data in accordance with the following:

a. Face each indicator on as direct a line of sight as possible to minimize parallax errors.

b. Observe temperatures to the nearest degree Fahrenheit from the left edge of the indicator.

c. Report data as missing if standby equipment is not available and reading exceeds the operating range of hygrothermometer.

d. If the temperature is below -35 degrees Fahrenheit, disregard the dew point indicated on the instrument and assume the temperature of the dew point to be the same as the temperature (dry-bulb) with respect to ice. Convert it to the corresponding dew point with respect to water using a psychrometric calculator or nomograph.

3.3 Psychrometer.

3.3.1 Dry-Bulb and Wet-Bulb Temperatures. Use a psychrometer equipped with mercury thermometers to determine dry- and wet-bulb temperatures if the dry-bulb temperature is above -35 degrees Fahrenheit. If the dry-bulb temperature is -35 degrees or less:

a. Use a psychrometer, equipped with a spirit thermometer, in the range of -50 degrees Fahrenheit to 110 degrees Fahrenheit or -80 degrees Fahrenheit to 110 degrees Fahrenheit, to obtain dry-bulb temperature.

b. Disregard the wet-bulb reading and use the dry-bulb temperature to compute the dew point. (Paragraph 3.3.2b.)

3.3.2 Dew-Point Temperatures. Obtain dew-point temperatures from:

a. Dry-bulb and wet-bulb temperatures if the temperature is above -35 degrees Fahrenheit, or

b. The dry-bulb temperature if the dry-bulb temperature is -35 degrees Fahrenheit or below. To do this, assume that the dew point with respect to ice is the same as the dry-bulb temperature and convert it to the corresponding dew point with respect to water using a psychrometric calculator or nomograph.

3.3.3 Observing Procedure. After properly ventilating the psychrometer quickly read both thermometers, wet-bulb first. Repeat until two successive wet-bulb readings are the same, indicating that the wet-bulb temperature has reached its lowest point. When readings are being made:

a. Stand as far from the thermometer as possible to prevent body heat from affecting the indicated readings.

b. Make sure that the line of sight from the eye to the top of the liquid column is at an angle (approximately 90 degrees) to minimize parallax errors.

3.3.3.1 Psychrometric Evaluations.

a. NEAR FREEZING TEMPERATURE. At wet-bulb temperatures near freezing, determine visually that the wet-bulb is unfrozen before using wet-bulb depression data.

b. TEMPERATURE BELOW FREEZING. At wet-bulb temperatures below 32 degrees Fahrenheit, if the wick is not frozen, touch it with clean ice, snow, or another cold object to induce freezing. Convert dew-point values with respect to ice to corresponding values over water.

c. UNOBTAINABLE DEPRESSION. When the wet-bulb is covered with water and a depression cannot be obtained, the relative humidity shall be regarded as 100 percent, and the temperature of the dew point the same as that of the wet-bulb. If the wet-bulb is covered with ice and a depression cannot be obtained, the temperture of the wet-bulb will be regarded as the dew point with respect to ice. The dew point shall be converted to its water equivalents unless liquid fog is present at the station. If liquid fog is present the dew point is the same as the wet-bulb temperature.

d. DEW POINT EQUALS OR EXCEEDS DRY-BULB. When dew-point temperature equals or exceeds the dry-bulb temperature:

(1) Assume wet-bulb and dew-point temperatures with respect to water to be the same as the dry-bulb temperature if the wet-bulb wick is not frozen or when liquid fog is present,

(2) Assume the wet-bulb and dew-point temperatures with respect to ice equal to the dry-bulb and convert them to their over-water equivalent if the wet-bulb is frozen or when ice fog is present.

3.3.3.2 Psychrometric Computations. Dry-bulb and the wet-bulb temperatures are used to calculate relative humidity and dew point with psychrometric tables, nomograms, or calculators based on atmospheric pressures of 23, 25, 27, 28, 29, and 30 inches of mercury. If a psychrometric calculator or nomogram is available, use it over its range rather than tables.

3.3.3.3 Dew-Point Conversion.

a. PSYCRHOMETRIC CALCULATOR. Use the appropriate psychrometric calculator to convert dew-point values with respect to ice to a corresponding dew point over water. On the low-temperature face of the calculator, equivalent values of dew point appear opposite each other on the DP (or T_w, DP) and T_i scale; e.g., a dew point of 20 degrees Fahrenheit with respect to ice is the equivalent of 18.5 degrees Fahrenheit with respect to water.

b. PSYCHROMETRIC TABLES. For psychrometric data outside the range of calculators, WS Table 235 or Smithsonian Meteorological Tables 99, 100, 101, and 102 may be used; Table 99 for reduction of the data; Tables 100 or 101 for converting relative humidities with respect to ice to relative humidity with respect to water; and Table 102 for similarly converting dew points.

4. Reporting Procedures. Determine and report dry-bulb and dew-point temperatures for each Record observation and for each Local observation taken upon notification of an aircraft accident. Dew point may be omitted if terminal forecasts are not required.

4.1 Entries on MF1-10C.

4.1.1 Temperature (Column 7). Enter dry-bulb temperature to the nearest whole degree Fahrenheit. Prefix subzero temperatures with a minus sign.

4.1.2 Dew-Point Temperature (Column 8). Enter dew-point temperature to the nearest whole degree Fahrenheit. Prefix subzero dew-point temperatures with a minus sign. At SAWRS and LAWRS stations this entry is included if needed for terminal forecasts.

4.1.3 Dry-Bulb and Wet-Bulb Temperatures (Columns 18 and 19). These columns are only completed if they are used to compute dew point; i.e., when a psychrometer is used. Enter data in degrees and tenths Fahrenheit.

5. Temperature and Humidity Instrumentation Operating Procedures.

5.1 Dry-Bulb Thermometer. When driving rain or snow is occurring, dry the bulb and shield it from the precipitation as long as necessary to permit dissipation of extranous heat before reading it again. Use this reading for psychrometric purposes rather than the reading normally made when lowest wet-bulb reading is taken. When frost forms on the thermometer, remove it with a warm cloth and allow sufficient time for the dissipation of extraneous heat before reading the thermometer.

5.2 Moistening the Wet-Bulb. The procedure used in moistening the wet-bulb varies according to whether the dry-bulb temperature is above freezing, near or below freezing, and whether the relative humidity is high or low.

5.2.1 Temperature Above Freezing. Moisten the wet-bulb with clean water just prior to ventilating the psychrometer (even though the humidity is high or the wick already appears wet). If temperature is high and relative humidity low, or you expect the wet-bulb will be 32 degrees or less, moisten the wet-bulb thoroughly several minutes before taking a reading so that a drop of water will have formed on the end of the bulb. This will reduce the temperature of the wet-bulb without the wick drying out before the temperature reaches its lowest point.

5.2.2 High Temperature and Low Humidity. In areas where the temperature is high and the relative humidity low, use precooled water for moistening the wet-bulb to avert premature drying of the wick. Water can be precooled for this purpose by storing it in a porous jar. To avoid altering moisture conditions in an instrument shelter, do not keep this jar in the shelter. If this method doesn't work, extend the wick from the wet-bulb to an open container of water and keep the end of the wick immersed in water between observations. When the psychrometer is ventilated, remove the wick from the water until the wet-bulb thermometer has been read. Regardless of the method used, ventilate the psychrometer in accordance with paragraph 5.3 before determining the wet-bulb temperature.

5.2.3 Dry-Bulb Temperature Below 38 Degrees Fahrenheit. At dry-bulb temperatures below 38 degrees Fahrenheit use water at room temperature to completely melt any accumulation of ice on the wet-bulb. Moisten the bulb thoroughly at least 15 minutes before ventilating the psychrometer, and longer if necessary to permit latent heat, released if the water freezes, to be dissipated before ventilation is begun. Do not allow excess water to remain on the wet-bulb, since a thin, thoroughly cooled coating is necessary for accurate data.

5.3 Psychrometer Ventilation. Ventilate the psychrometer for about 10 seconds. The minimum speed of air passing over the psychrometer bulbs should be 15 feet per second. This is approximately one revolution per second of the geared (2 to 1 ratio) whirling psychrometer crank, two revolutions per second of the sling psychrometer, and three and one-half revolutions per second of the crank of the psychrometer fan or motor (direct-drive) whirling psychrometer.

5.3.1 Sling Psychrometer Ventilation. Ventilate the sling psychrometer as follows:

a. Select a shady spot with no obstructions within a radius of the whirling sling,

b. Face into the wind,

c. Hold the handle at arm's length while whirling the psychrometer.

5.3.2 Obtaining Readings. After proper ventilation has been achieved, quickly read both thermometers, wet-bulb first. Repeat until two successive wet-bulb readings are the same, indicating that the wet-bulb temperature has reached its lowest point. If the wet-bulb temperature rises between successive readings, remoisten the wick and reventilate. Accurate readings are especially important at low temperatures, where a given wet-bulb depression has a greater effect on the accuracy of psychrometric computations.

5.4 Psychrometric Calculator. Use the scale based on the barometric pressure nearest the normal station pressure (e.g., sea-level stations will use 30-inch scale for all observations). At stations where the normal station pressure is unknown, the appropriate scale should be based on the elevation of the station, using table A7-1 as a guide in selecting a satisfactory scale.

5.4.1 Using the Calculator. Instructions for using the calculator are printed on it. Note that a different temperature scale is used when the wet-bulb is covered with ice. When the wet-bulb temperature is 32 degrees or more, use the high temperature range of the calculator; when the wet-bulb temperature is less than 32 degrees, use the low temperature range. It is your responsibility to try to induce freezing when the wet-bulb is below 32 degrees. If you can't induce freezing, follow the instructions on the low temperature range relating to a wet (or frozen) wick on the wet-bulb.

Table A7-1. Selection of Psychrometric Calculator on Basis of Station Elevation

Station Elevation (Feet)	Computer Pressure Base (Inches of Mercury)
-531 to +392	30
393 to 1341	29
1342 to 2316	28
2317 to 3836	27
3837 to 5976	25
above 5976	23

Based on ICAO Standard Atmosphere

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CHAPTER A8

WIND

1. General.

1.1 Wind is measured in terms of velocity, a vector that includes direction and speed. The absence of apparent motion of the air is termed "CALM." The direction and speed of the wind should be measured in an unsheltered area. This will avoid, to a large degree, the measuring of wind directions and speeds that have been disturbed by local obstructions and will result in the reporting of winds more representative for aircraft operations.

2. Definitions.

2.1 Wind Speed. Wind speed is the horizontal speed of air past a given point.

2.2 Wind Direction. Wind direction is the direction from which the wind is blowing.

2.3 Variable Wind Direction. Wind direction is considered variable when during the period of observation the wind speed is more than 6 knots and the direction fluctuates by 60 degrees or more.

2.4 Light Wind. The wind is considered to be light when the speed is 6 knots or less.

2.5 Gust. Rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls.

2.6 Squall. A sudden increase of at least 15 knots in average wind speed and sustained at 20 knots or more for at least 1 minute.

2.7 Wind Shift. A term applied to a change in wind direction of 45 degrees or more that takes place in less than 15 minutes.

2.9 Magnetic Variation. Magnetic variation is the angle between true north and magnetic north. It is "east" if the compass needle points to the east of the geographical meridian, west if the needle points to the west.

3. Observing and Reporting Procedures.

3.1 Wind Direction.

a. Instrument Determination - When direct reading dials are used, determine the wind direction by averaging the observed directions over a 1-minute period.

b. Estimating Wind Direction - If the wind direction indicator is inoperable, estimate the direction by observing the wind cone, tee, movement of twigs, leaves, smoke, etc. When estimating wind direction note that even small obstacles may cause variation in wind direction. Never use the movement of clouds, regardless of how low, to estimate wind direction.

3.2 Wind Speed.

a. Instrumental Determination - Use direct reading dials to determine speed to the nearest knot. Average observed values over a 1-minute period.

b. Estimating Wind Speed - Use the Beaufort Scale, table A8-1, if instruments are inoperable or the wind speed is below the starting speed of the anemometer.

3.3 Character of Wind. Gusts or squalls are indicated on direct reading wind speed indicators by rapid fluctuation and sudden increases and decreases of wind speed. If criteria given in paragraphs 2.5 or 2.6 are met the speed of the gust or squall is the maximum instantaneous speed observed.

3.4 Reporting Wind Direction, Speed, and Character. Wind direction and speed are reported in all observations except single element Specials. Gusts or squalls are reported if they are observed to occur during the 10-minute period prior to the observation.

3.5 Units Used. In Aviation observations direction is reported to the nearest 10 degrees with reference to true north and speed is reported in nautical miles per hour (knots). Tens of degrees and true reportable values are shown in table A8-2.

3.6 Recording Data On MF1-10C. Enter in columns 9, 10, and 11 wind direction, speed, and character, respectively. When the speed is calm enter "00" in columns 9 and 10. When wind speed is 100 knots or more add 50 to the wind direction in column 9 and enter the tens and units digit of the wind speed in column 10.

3.6.1 Estimated Data. When either the wind direction, speed or character is estimated, prefix the direction with an "E."

3.7 Examples of Recorded Data.

WIND		
DIRECTION (00-36) (9)	SPEED (Kts.) (10)	CHARACTER (11)
00	00	
76	12	
E01	07	

Wind Speed Calm True Direction ___ degrees

Wind Speed 112 kt True Direction 260 degrees

Wind Speed 7 kt* True Direction 10 degrees

*Estimated

3.8 Reporting a Wind Shift. A Special observation is required whenever a wind shift is observed. This observation will contain in column 13, Remarks, the contraction WSHFT and the time of occurrence; e.g., WSHFT 23.

3.9 Variable Wind Direction. If wind direction fluctuates by 60 degrees or more during the period of observation (1 minute) and wind speed is more than 6 knots, enter in column 13, Remarks, "WND" followed by extremes of variability separated by a "V"; e.g., WND 27V34.

3.11 Conversion of True and Magnetic Winds. Obtain the local magnetic variation from an aeronautical chart and proceed as follows:

a. To convert from true to magnetic wind:

(1) Add westerly variation to true direction.

(2) Subtract easterly variation from true direction.

b. To convert from magnetic to true direction:

(1) Add easterly variation to magnetic direction.

(2) Subtract westerly variation from magnetic direction.

Table A8-1. Wind Equivalent--Beaufort Scale

Beaufort Number	MPH	Knots	International Description	Specifications
0	Less than 1	Less than 1	Calm	Calm; smoke rises vertically
1	1- 3	1- 3	Light air	Direction of wind shown by smoke drift but not by wind vanes.
2	4- 7	4- 6	Light Breeze	Wind felt on face; leaves rustle; vanes moved by wind
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag
4	13-18	11-16	Moderate	Raises dust, loose paper; small branches moved
5	19-24	17-21	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters
6	25-31	22-27	Strong	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty
7	32-38	28-33	Near gale	Whole trees in motion; inconvenience felt walking against wind
8	39-46	34-40	Gale	Breaks twigs off trees; impedes progress
9	47-54	41-47	Strong gale	Slight structural damage occurs
10	55-63	48-55	Storm	Trees uprooted; considerable damage occurs
11	64-72	56-63	Violent storm	Widespread damage
12	73-82	64-71	Hurricane	

Table A8-2. WIND DIRECTION IN TENS OF DEGREES (TRUE)

Degrees True	Compass Points	Tens of Degrees	Degrees True	Compass Points	Tens of Degrees
355-004	N	36	175-184	S	18
005-014		01	185-194		19
015-024	NNE	02	195-204	SSW	20
025-034		03	205-214		21
035-044		04	215-224		22
045-054	NE	05	225-234	SW	23
055-064		06	235-244		24
065-074	ENE	07	245-254	WSW	25
075-084		08	255-264		26
085-094	E	09	265-274	W	27
095-104		10	275-284		28
105-114	ESE	11	285-294	WNW	29
115-124		12	295-304		30
125-134		13	305-314		31
135-144	SE	14	315-324	NW	32
145-154		15	325-334		33
155-164	SSE	16	335-344	NNW	34
165-174		17	345-354		35

Table A8-3. Conversion of Miles per Hour to Knots

Miles per Hour	0	1	2	3	4	5	6	7	8	9
	kn	kn	kn	kn	kn	kn	kn	kn	kn	kn
0	0	1	2	3	3	4	5	6	7	8
10	9	10	10	11	12	13	14	15	16	17
20	17	18	19	20	21	11	23	23	24	25
30	26	27	28	29	30	30	31	32	33	34
40	35	36	36	37	38	39	40	41	42	43
50	43	44	45	46	47	48	49	50	50	51
60	52	53	54	55	56	56	57	58	59	60
70	61	62	63	63	64	65	66	67	68	69
80	70	70	71	72	73	74	75	76	76	77
90	78	79	80	81	82	83	83	84	85	86

Note: This table is not reversible. Do not use it to convert knots to miles per hour.

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CHAPTER A9

SPECIAL OBSERVATIONS, LOCAL OBSERVATIONS, AND SIGNIFICANT REMARKS

1. Content. This chapter contains criteria requiring Special observations, Local observations, and remarks in column 13.

2. Special Observations (S). Take, record, and disseminate a Special observation whenever any of the following are observed:

a. CEILING. The ceiling (rounded to reportable values) forms or dissipates below, decreases to less than, or if below, increases to equal or exceed:

(1) 3000 feet,

(2) 1000 feet,

(3) 500 feet,

(4) All nationally published landing minima, applicable to the airport, listed in the National Ocean Survey (NOS) Instrument Approach Procedure Chart,

b. SKY CONDITION. A layer of clouds or obscuring phenomena aloft appears below:

(1) 1000 feet, and no layer was reported below 1000 feet in the preceding R or S observation,

(2) The highest instrument landing minimum applicable to the airfield and no sky cover was reported below this height in the previous R or S observation.

c. VISIBILITY. Prevailing visibility (rounded to reportable values) decreases to less than, or if below, increases to equal or exceed:

(1) 3 miles,

(2) 2 miles,

(3) 1 1/2 miles,

(4) 1 mile,

(5) All nationally published landing minima, applicable to the airport, listed in the National Ocean Survey (NOS) Instrument Approach Procedure Charts.

e. TORNADO, FUNNEL CLOUD, or WATERSPOUT.

(1) Is observed,

(2) Disappears from sight.

f. THUNDERSTORM.

(1) Begins (a Special observation is not required to report the beginning of a new thunderstorm if one is currently reported in progress at the station),

(2) Increases in intensity (T to T+),

(3) Ends. (15 minutes after thunder is last heard.)

g. PRECIPITATION.

(1) Hail begins or ends,

(2) Freezing precipitation begins, ends, or changes intensity,

(3) Ice pellets begin, end, or change intensity.

h. WIND and WIND SHIFTS.

(1) The average 1-minute wind speed suddenly increases to at least twice the currently reported 1-minute wind speed, and exceeds 25 knots,

(2) Wind shifts.

j. MISCELLANEOUS. Any other meteorological situation which, in the opinion of the observer, is critical to the safety of aircraft operations.

3. Aircraft Mishap. An inclusive term to denote the occurrence of an aircraft accident, incident, or inflight emergency which could adversely affect the safety of the aircraft. (Includes nonflight aircraft accident when weather is a possible factor, and includes accidents occurring in flight or when an intent for flight exists.)

4. Local Observations (L). Local observations may be taken and recorded at any weather observing station for reasons other than those listed below. The content and criteria for these observations is determined locally. Local observations will be:

a. Taken and recorded immediately following notification of an Aircraft Mishap (other than an inflight emergency) unless there has been an intervening Record or Special observation. Upon notification of an inflight emergency, intensify the weather watch and take and disseminate weather data as necessary to ensure maximum support to the aircraft in distress. If the inflight emergency results in an accident or incident, a Local observation must be taken and recorded. In a Local observation following an Aircraft Mishap include all elements normally included in a Record observation. Include any other desirable explanatory material in Remarks and identify the observation by the remark ACFT MISHAP, in parentheses. Do not disseminate the remark ACFT MISHAP.

b. Taken for any other meteorological situation which, established locally or in the opinion of the observer, is critical to local operations.

5. Remarks Pertaining to Preceding Coded Elements. Information considered operationally significant, or information needed to amplify preceding coded data, should be included in Remarks. Remarks on variability (ceiling, sky condition, visibility, intermittent precipitation, etc.) are not to be used as a means of circumventing the requirement for Special or Local observations. Some of the more common remarks which should be appended to weather observations, when appropriate, are as follows:

Observed	Entry in Column 13
a. CEILING AND SKY CONDITION.	
(1) Breaks in overcast not classified as thin.	"BINOVC" followed by direction from station; e.g., BINOVC NE. No direction required if occurring in all quadrants.
(2) Higher clouds visible thru breaks in overcast not classified as thin.	"HIR CLDS VSB" and direction(s) from station; e.g., HIR CLDS VSB NE AND S. No direction required if occurring in all directions.
(3) Direction of breaks or an area absent of clouds in a broken layer below 1000 feet.	"BRKS" followed by direction from station; e.g., BRKS N or BRKS OVR MMKR (Omit direction if breaks are in all quadrants).
(4) Obscuring phenomena aloft.	Type, followed by height and corresponding sky cover contraction (as reported in column 3); e.g., K10 BKN.
(5) Special cloud types:	
(a) Towering cumulus.	"TCU" distance (if known), and direction from station; e.g., TCU NE, TCU 25SW.
(b) Cumulonimbus and a thunderstorm is not being reported.	"CB" followed by distance from station (if known), direction from station, and movement (if known); e.g., CB 20S MOVG NE, CB OVHD MOVG E.
(c) Cumulonimbus mamma (with or without thunder).	Same as cumulonimbus except use "CBMAM" in place of "CB"; e.g., CBMAM 10W MOVG SE.

(d)	Altocumulus castellanus.	"ACCAS" followed by direction from station; e.g., ACCAS NE.
(e)	Standing lenticular clouds or rotor clouds.	Description followed by direction from station, e.g, ACSL SW-WNW or APRNT ROTOR CLOUDS S, CCSL OVR MTNS W.
(6)	Variable sky condition during the period of observation (normally, the past 15 minutes).	The condition existing at the actual time of observation, the letter "V," and the condition to which it varied during the period of observation; e.g., BKN V SCT. Include the height when necessary to distinguish between column 3 entries; e.g., 18 BKN V OVC.
(7)	Variable ceiling below 3000 feet.	"CIG" followed by extremes of variability separated by a "V"; e.g., CIG 15V20.
(8)	Ceiling and sky condition at a distance differing from that at station.	Description and location; e.g., CIG LWR OVR CITY, LWR CLDS W APCHG STN, CLD BASE OBSCD BY MTNS W.
(9)	A surface based obscuration hides part (not all) of the sky (-X).	Enter type of obscuration and tenths of sky hidden; e.g., F6, KF2.
(10)	Sky cover at and below a layer aloft is less than one-tenth (nearest tenth).	Type of cloud and direction from station; e.g., ST W, CUFRA N.

b. VISIBILITY.

(1)	Prevailing visibility less than 3 miles, varying by one or more reportable values.	"VSBY" followed by extremes of variability separated by "V"; e.g., VSBY 1/4V1/2.
(2)	Sector visibility less than 3 miles or operationally significant and differing from the prevailing visibility.	"VSBY" sector and visibility in that sector(s); e.g., VSBY N2, VSBY NW2S1/2.

c. WEATHER AND OBSTRUCTIONS TO VISION.

(1) TORNADO, WATERSPOUT, or FUNNEL CLOUD:		
	(a) Observed while still in progress by station personnel.	Description, direction from station, movement; e.g., FUNNEL CLOUD W MOVG NE.
	(b) Observed by station personnel and has ended or disappeared.	Description and direction of movement; e.g, TORNADO MOVD NE.
(2) Thunderstorms:		
	(a) In progress at station.	The direction from station, and if known, the distance and the direction of movement for each center of activity; e.g., T W MOVG E.
	(b) Has ended or disappeared.	"T" and direction of movement; e.g., MOVD E.
(3) Lightning.		Frequency, type, and direction from station; e.g., OCNL LTGCCCG N. Direction may be omitted if the same as that of the thunderstorm remark; e.g., FQT LTGICCA.
(4) Precipitation:		
	(a) Hail.	The diameter in inches of the largest hail stones; e.g., HLSTO 1/4, or HLSTO 2.
	(b) Precipitation varying in intensity during the period of observation.	Type and intensity (as reflected in column 5), "OCNLY," and type and intensity to which it varied during the period of observation; e.g., R- OCNLY R, SW OCNLY SW-.

(c)	Precipitation at a distance from (but not at) the station.	Type and intensity (or "U" if unknown), and direction from station; e.g., RWU NW, SW OVR MTNS SE.
(d)	Intermittent precipitation having occurred within the past 15 minutes or occurring at observation time.	Type and intensity; e.g., INTMT R-.
(e)	Showers having occurred within the past 15 minutes, but not occurring at observation time.	Frequency of showers, type, and intensity; e.g., OCNL RW.

(5) Obstruction to Vision:

(a)	Fog dissipating or increasing.	Enter "F DSIPTG" or "F INCRG."
(b)	Smoke drifting over field.	"K DRFTG OVR FLD."
(c)	Shallow ground fog (height less than 6 feet).	"SHLW GF" followed by "DEP" and depth in feet, if known; e.g., SHLW GFDEP4.
(d)	Drifting snow (height less than 6 feet).	"DRFTG SNOW" if blowing snow is not being reported.
(e)	Dust devils.	"DUST DEVILS" followed by direction from station; e.g., DUST DEVILS SW AND NW.
(f)	Obscuring phenomena at a distance from and not at the station.	Enter type, description, and direction from the station; e.g., F BANK N-E-S.

d. WIND.

(1) Wind direction varying by 60 degrees or more during period of observation with wind speed more than 6 knots.	"WND" followed by extremes of variability separated by a "V"; e.g., WND 27V34.
(2) Wind shifts in direction by 45 degrees or more within a 15-minute period.	"WSHFT" and time of occurrence; e.g., WSHFT 30.

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